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Part II

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CAST ALUMINUM STRUCTURES TECHNOLOGY (CAST) STRUCTURAL TEST AND EVALUATION (PHASE V) PART II—FATIGUE AND FRACTURE PROPERTIES OF CAST ALUMINUM BULKHEADS

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The Boeing Company
Seattle, Washington 98124

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Final Report for Period February 1977-January 1980

Flight Dynamics Laboratory
Air Force Wright Aeronautical Laboratories
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Wright-Patterson Air Force Base, Ohio 45433

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The fatigue and fracture properties of four cast A357-T6 aluminum alloy bulkheads ~~produced by the Boeing and Hitchcock foundries~~, were investigated. Constant amplitude fatigue, crack growth, and fracture-toughness specimens were excised from the bulkheads for this purpose. The data obtained from these specimens confirmed the assumed properties used in the durability and damage tolerance analyses of the bulkhead.

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FOREWORD

This report was prepared by the Boeing Military Airplane Company, Advanced Aircraft Branch, Seattle, Washington under USAF Contract No. F33615-76-C-3111. The contract work was performed under project 486U under the direction of the Flight Dynamics Laboratory, Advanced Metallic Structures/Advanced Development Program Office, Wright-Patterson AFB, Ohio. A significant portion of the contract was funded by the Metals Branch of the Manufacturing Technology Division of the Materials Laboratory. The Air Force Project Engineer was John R. Williamson of the AMS Program Office, Structural Mechanics Division, Flight Dynamics Laboratories (AFWAL/FIBAA).

The Boeing Military Airplane Company was the contractor with Donald E. Strand as Program Manager and Donald D. Goehler as Technical Leader. Work covered by this report was conducted by Christian K. Gunther.

This report is Part II of a three-part report on Phase V activities. The contractor's report number is D180-25724-2. The report covers work from February 1977 through January 1980. Other work performed on the CAST program is reported in:

- AFFDL-TR-77-36 Final Report (Phase I) for period June 1976—February 1977
- AFFDL-TR-78-62 Final Report (Phase II) for period June 1976—March 1978
- AFFDL-TR-78-7 Final Report (Phase III) for period February 1977—December 1977
- AFFDL-TR-79-3029 Final Report (Phase IV) for period June 1977—March 1979

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INTRODUCTION

During the course of the CAST program, fatigue and fracture data were developed to support the durability and damage tolerance analysis efforts. These data were obtained from specimens that were machined from separately cast plates and blocks (ref. 1). Although a relatively large number of specimens were tested, the question of what the properties of the cast bulkheads were remained. Unlike data of wrought materials, separately cast specimen data do not necessarily correlate to properties of full-scale castings. A large number of foundry variables, such as location of chills and risers, greatly influence the material properties. Therefore, fatigue and fracture properties evaluation of the cast bulkheads was performed in addition to the full-scale test evaluation of structural integrity. The data of reference 1 will be referred to as separately cast specimen data in this report, in contrast to the data obtained from specimens excised from the bulkheads.

SECTION II

FATIGUE AND FRACTURE TEST DATA

1. TEST SPECIMEN ORIGIN

Twenty cast aluminum (A357-T6) bulkheads (Fig. 1) were produced by the Boeing and Hitchcock foundries during Phase IV of the CAST program (ref. 2). The Hitchcock castings were produced according to Boeing's manufacturing plan and with Boeing-developed and furnished tooling. Two bulkheads were selected from each foundry for mechanical, fatigue, and fracture property testing. The results of the mechanical property testing are discussed in Part III of this report, reference 3. The selected bulkheads are identified as follows:

Boeing foundry	M08, M09
Hitchcock foundry	N02, N09

The Boeing castings were cut into five pieces as shown in Figure 2 prior to heat treatment. The Hitchcock castings were heat treated in one piece. Heat treatment of all castings was as follows:

Solution heat treatment:	1010 $\pm$ 10°F for 24 to 25 hours
Quench delay:	10 seconds maximum
Quenchant:	106 $\pm$ 15°F water
Natural aging:	Room temperature for 16 to 24 hours
Precipitation heat treatment (aging):	325 $\pm$ 10°F for 7 to 8 hours

Constant-amplitude fatigue specimens were obtained from each of the four castings. They were removed from the sidewalls of the corrugations in Zone 1 (Fig. 2). Crack growth specimens were removed from the shear webs in Zones 3 and 5. Only the attachment lugs, among the critical areas, were thick enough to remove compact specimens for fracture toughness testing. Specimens were obtained from lugs number 1, 2, 7, and 8 from each casting. Table 1 summarizes this information and presents the total number of specimens involved in the investigation.

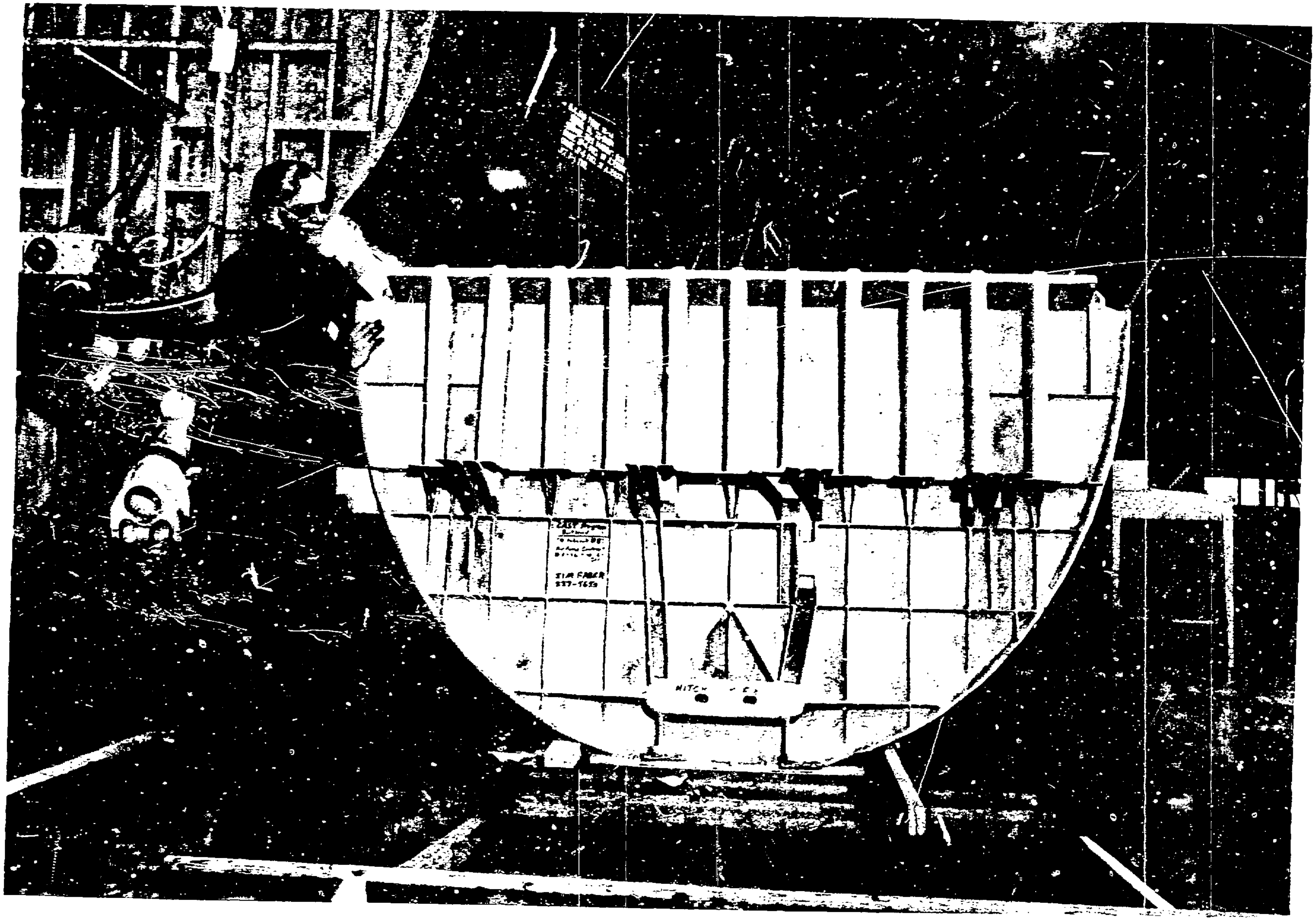

Figure 1. Cast Aluminum Bulkhead for YC-14

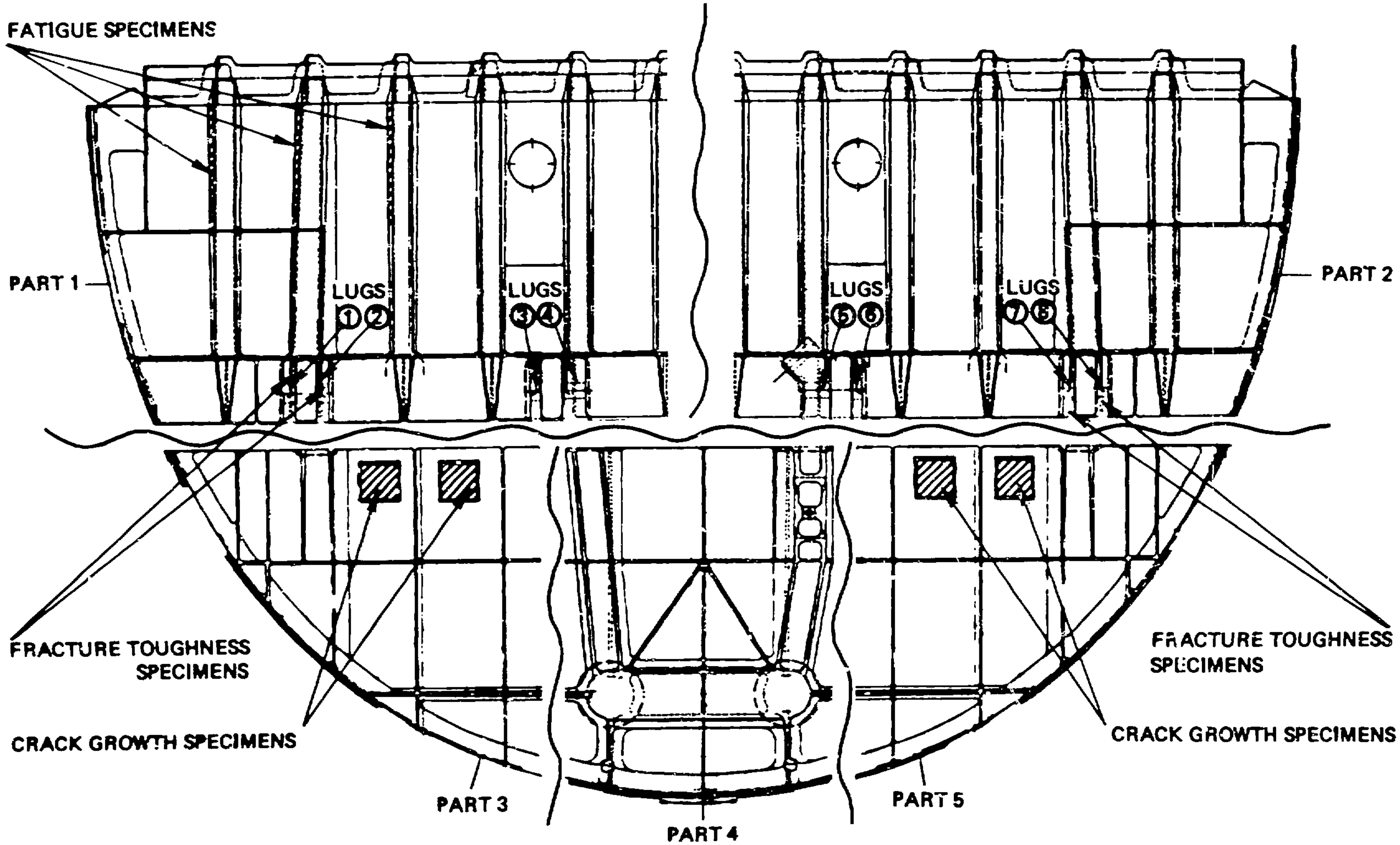

Figure 2. Specimen Locations On Cast Bulkhead

Table 1. Specimen Summary

Specimen ID	Casting	Location on casting	Purpose
NSNH2C1, NSNH2C2, NSNH2C3	Hitchcock No. 2	Part 1, corregation 1, 2, 3	Fatigue
NSNH9C1, NSNH9C2, NSNH9C3	Hitchcock No. 9	Part 1, corregation 1, 2, 3	Fatigue
NSN8C1, NSN8C2, NSN8C3	Boeing MO8	Part 1, corregation 1, 2, 3	Fatigue
NSN9C1, NSN9C2, NSN9C3	Boeing MO9	Part 1, corregation 1, 2, 3	Fatigue
SEN 23-1, -2*	Hitchcock No. 2	Part 3	Crack growth
SEN 25-1, -2	Hitchcock No. 2	Part 5	Crack growth
SENH 93-1, -2	Hitchcock No. 9	Part 3	Crack growth
SENH 95-1, -2	Hitchcock No. 9	Part 5	Crack growth
SEN 8-3,	Boeing MO8	Part 3	Crack growth
SEN 85-1, -2	Boeing MO8	Part 5	Crack growth
SEN 93-1, -2	Boeing MO9	Part 3	Crack growth
SEN 95-1, -2	Boeing MO9	Part 5	Crack growth
CH2L1, CH2L2, CH2L7, CH2L8	Hitchcock No. 2	Lugs 1, 2, 7, 8	Fracture toughness
CH9L1, CH9L2, CH9L7, CH9L8	Hitchcock No. 9	Lugs 1, 2, 7, 8	Fracture toughness
C8L1, C8L2, C8L7, C8L8	Boeing MO8	Lugs 1, 2, 7, 8	Fracture toughness
C9L1, C9L2, C9L7, C9L8	Boeing MO9	Lugs 1, 2, 7, 8	Fracture toughness

*Specimens Lost In Machine Shop

2. FATIGUE TEST RESULTS

Constant-amplitude fatigue tests were conducted according to ASTM recommended practice (ref. 4) as much as possible. The specimen surfaces were basically left as-cast, except that some cleanup was peformed when protrusions were present. Because of the nature of the castings, the specimens did not have completely uniform thicknesses and were not completely flat. The specimen geometry was as shown in Figure 3. All tests were performed in laboratory air environment at a stress ratio of R = 0.06. The test results are summarized in Table 2. A comparison of these data to the separately cast specimen data is shown in Figure 4. The bulkhead data are scattered over a wider range of cycles to failure, but the number of data points also is larger at this maximum stress level. Assuming a two-parameter Weibull distribution for S-N data, it is found that the number of cycles for 37% probability of survival (61,000) for these data is approximately the same as for the independent specimen data (56,000).

For Boeing durability analysis, it is customary to express S-N curves as a four-parameter family of curves, i.e.:

$$f_{max} = f(DFR, f_{mo}, S, R, N)$$

where DFR, f_{mo}, S, and R are the parameters and N, number of cycles, is the independent variable. It has been found that the parameters f_{mo} and S are material-dependent and can be kept constant for a given material. The parameter R is the stress ratio. Therefore, the geometric effects on fatigue life or the quality of the structure with respect to fatigue can be expressed solely by the detail fatigue rating, DFR.

A DFR of 11 for a stress concentration of k_t = 3.0 was used in the durability analysis of the bulkhead (ref. 5). The data presented here yield a DFR of 11.9, which is approximately the same as for the separately cast specimen data. Since a higher DFR means better fatigue quality, it is thus demonstrated that a slightly conservative DFR or, in other words, a slightly conservative S-N curve, was used in the Phase III durability analysis.

Table 2. Fatigue Test Results

Specimen ID	Max. fatigue stress (ksi) R = .06	Cycles to failure
NSNH2C1	12.6	287000 1/
NSNH2C2	18	35000
NSNH2C3		46000
NSNH9C1		103000
NSNH9C2		44000
NSNH9C3		39000
NSN8C1		31000
NSN8C2		56000
NSN8C3		7000 2/
NSN9C1		33000
NSN9C2		30000
NSN9C3		30000

1/Tested at 12.6 ksi in error, grip failure

2/Grip failure

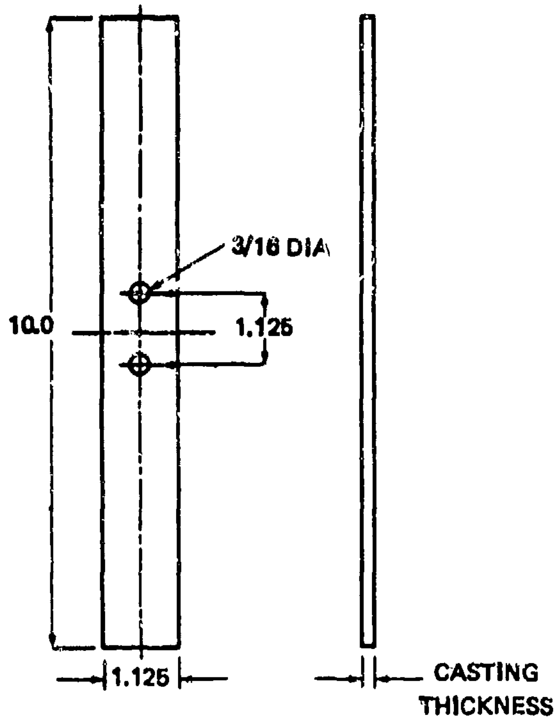

Figure 3. Fatigue Test Specimen

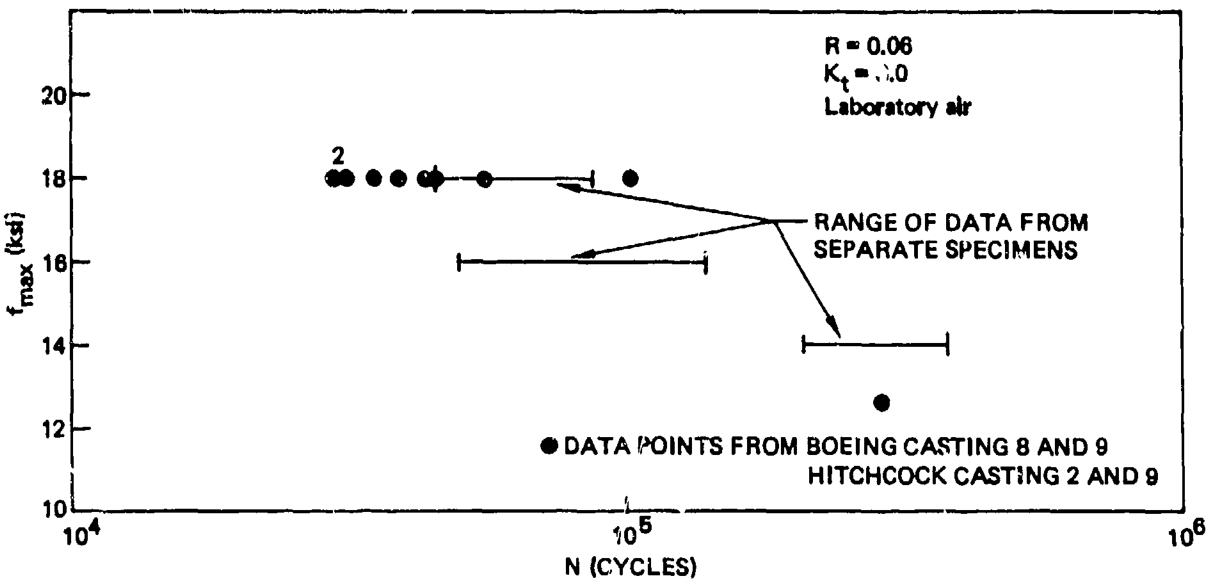

Figure 4. Fatigue Test Results

If one examines the Boeing and Hitchcock data separately, it is found that the fatigue quality of the Hitchcock castings in the area investigated was better. The DFR for the Hitchcock castings was found to be 12.2, while the DFR for the Boeing castings was 10.5 (Table 3). A large margin on fatigue life was predicted, such that this slightly lower DFR for the Boeing castings is of no consequence.

3. CRACK GROWTH RATE TEST RESULTS

Crack growth rate tests were conducted according to the ASTM tentative test method (ref. 6). The compact-type specimen was used (Fig. 5). All testing was performed in laboratory air environment. A record of crack length versus number of load cycles was obtained by using bonded-on, resistance-type foil gages. The laboratory test reports are contained in Appendix A. These crack growth rate data have been combined in Figure 6 and compared to the data obtained from the separately cast specimens. It is seen that the two sets of data are in general agreement. It is noted that, upon removal of data from specimens SEN 95-1, SEN 95-2, SENH 95-1, and SENH 95-2 (Fig. 7), the remaining data exhibit considerably reduced scatter (Fig. 8). It is further noted that the removed data (Fig. 7) represent crack growth rates of the same area of the four bulkheads (Area 5, Fig. 2) exclusively. An examination of the fracture surfaces by optical microscope to 30X magnification indicates that there is a slight increase in microshrinkage in these specimens compared to the others.

The crack growth rate expression:

$$da/dN = C(1 - R)^m (K_{max})^n,$$

where C, m, n are material related constants, K_{max} is the maximum stress intensity factor, and R is the stress ratio, was least-squares-fitted to (1) all bulkhead data, (2) the Hitchcock data, and (3) the Boeing bulkhead data. Figure 9 shows the resulting lines. There is no significant difference between the Boeing and Hitchcock data. Also, the difference between the crack growth rates used for the Phase III crack growth analyses and the data obtained from this investigation is negligible and the analysis is conservative in the low K regime.

Table 3. Detail Fatigue Ratings

Castings	Characteristic life* (cycles)	DFR
Hitchcock	70,853	12.1
Boeing	40,584	10.5

* Characteristic life corresponds to 37% probability of survival

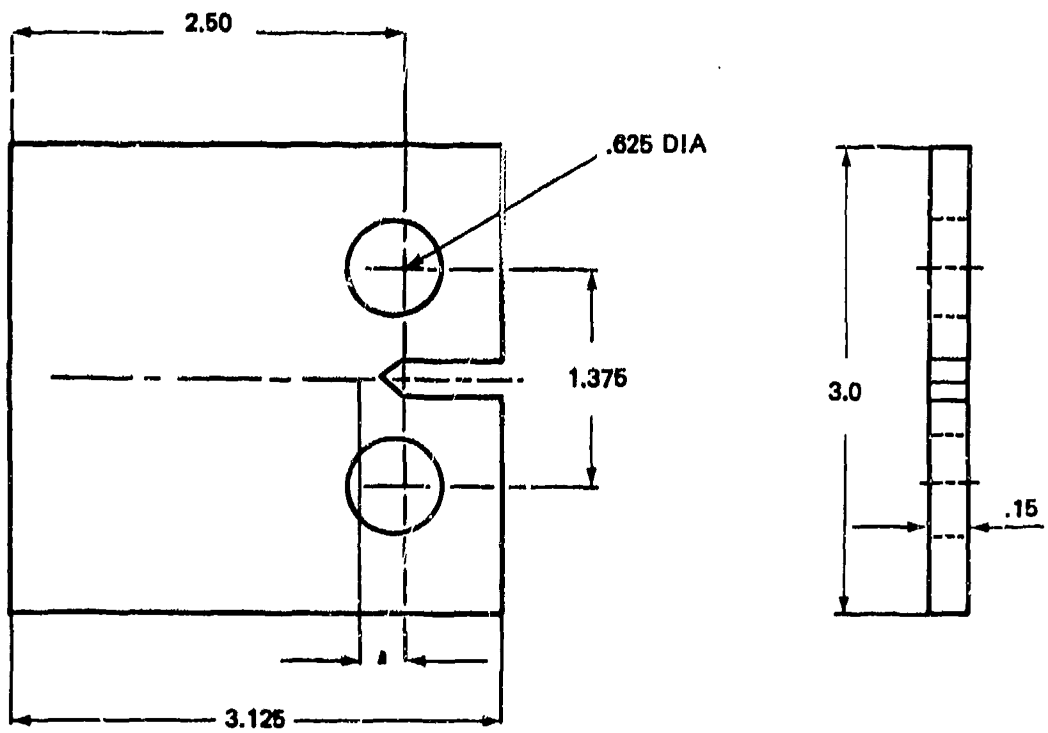

Figure 5. Crack Growth Rate Test Specimen

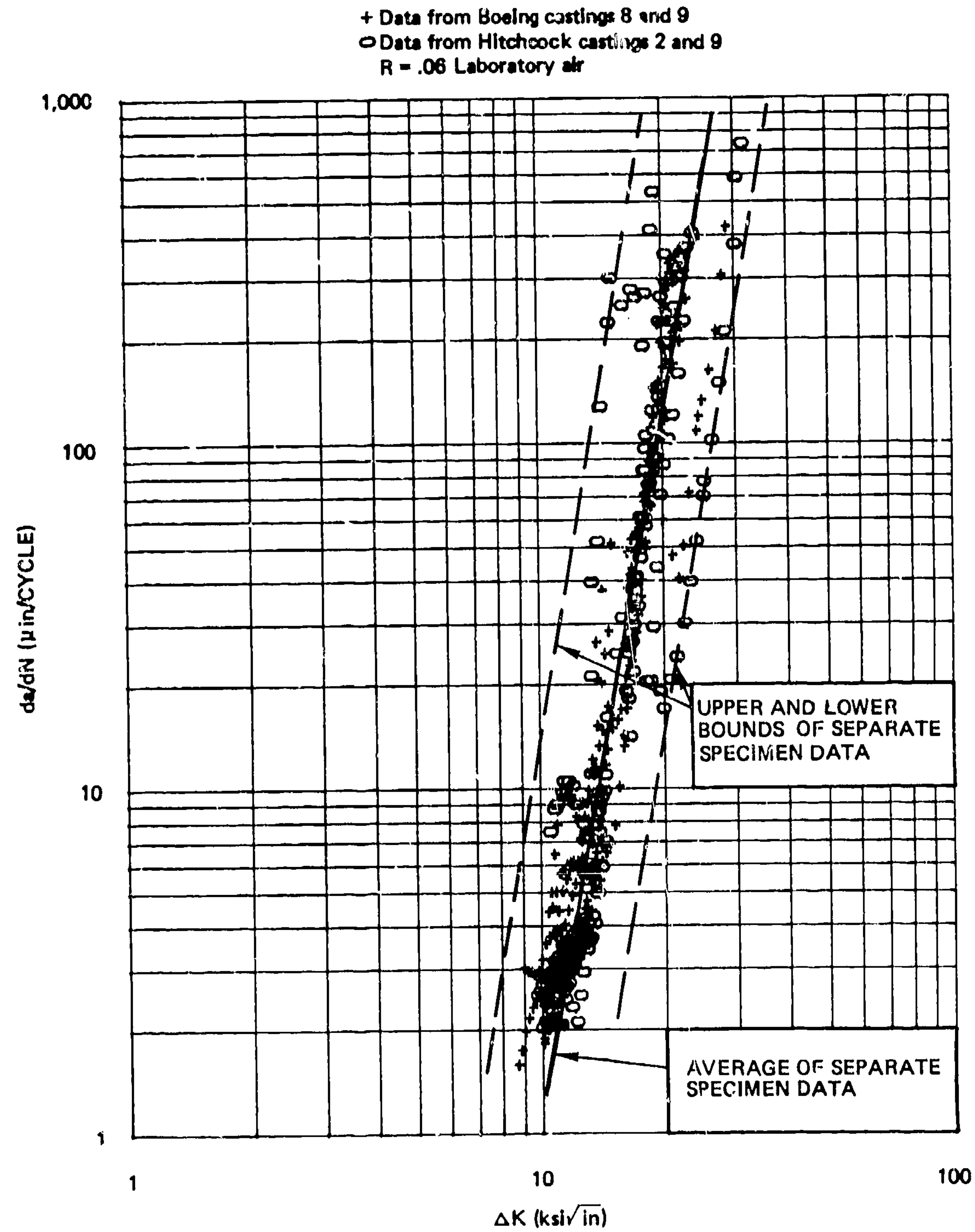

Figure 6. Crack Growth Rates--All Specimens

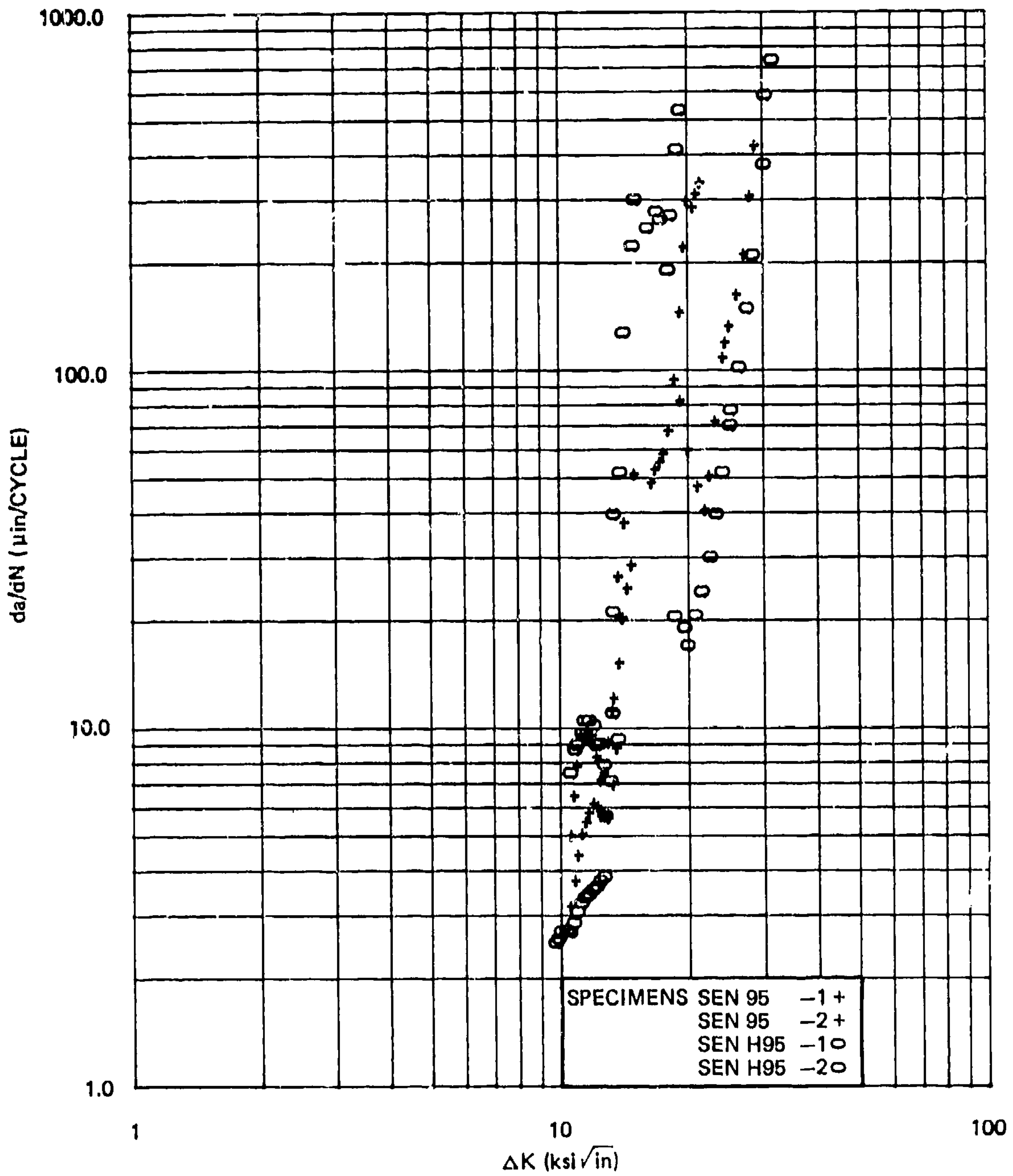

Figure 7. Crack Growth Rates--Selected Specimens I

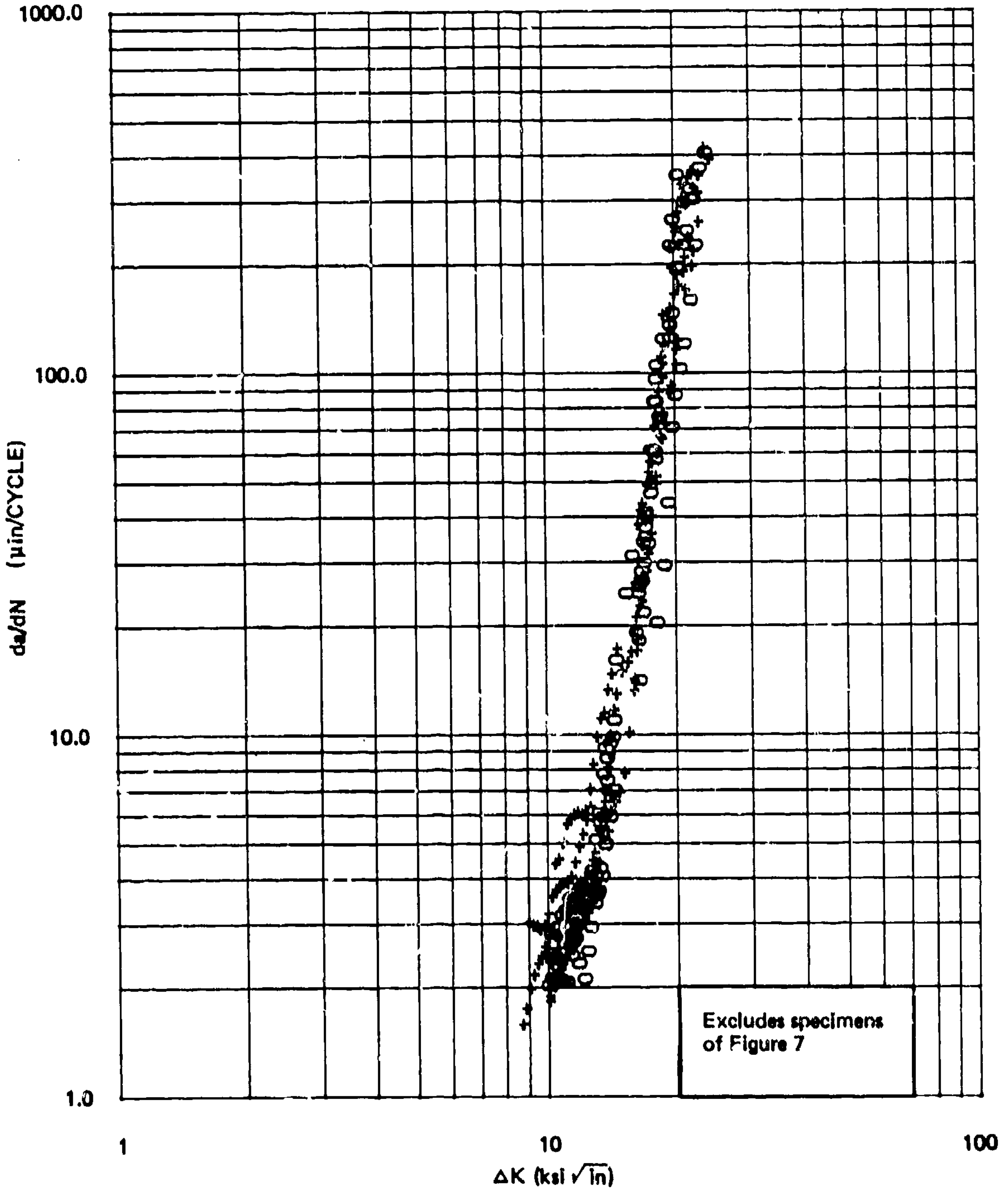

Figure 8. Crack Growth Rates--Selected Specimens II

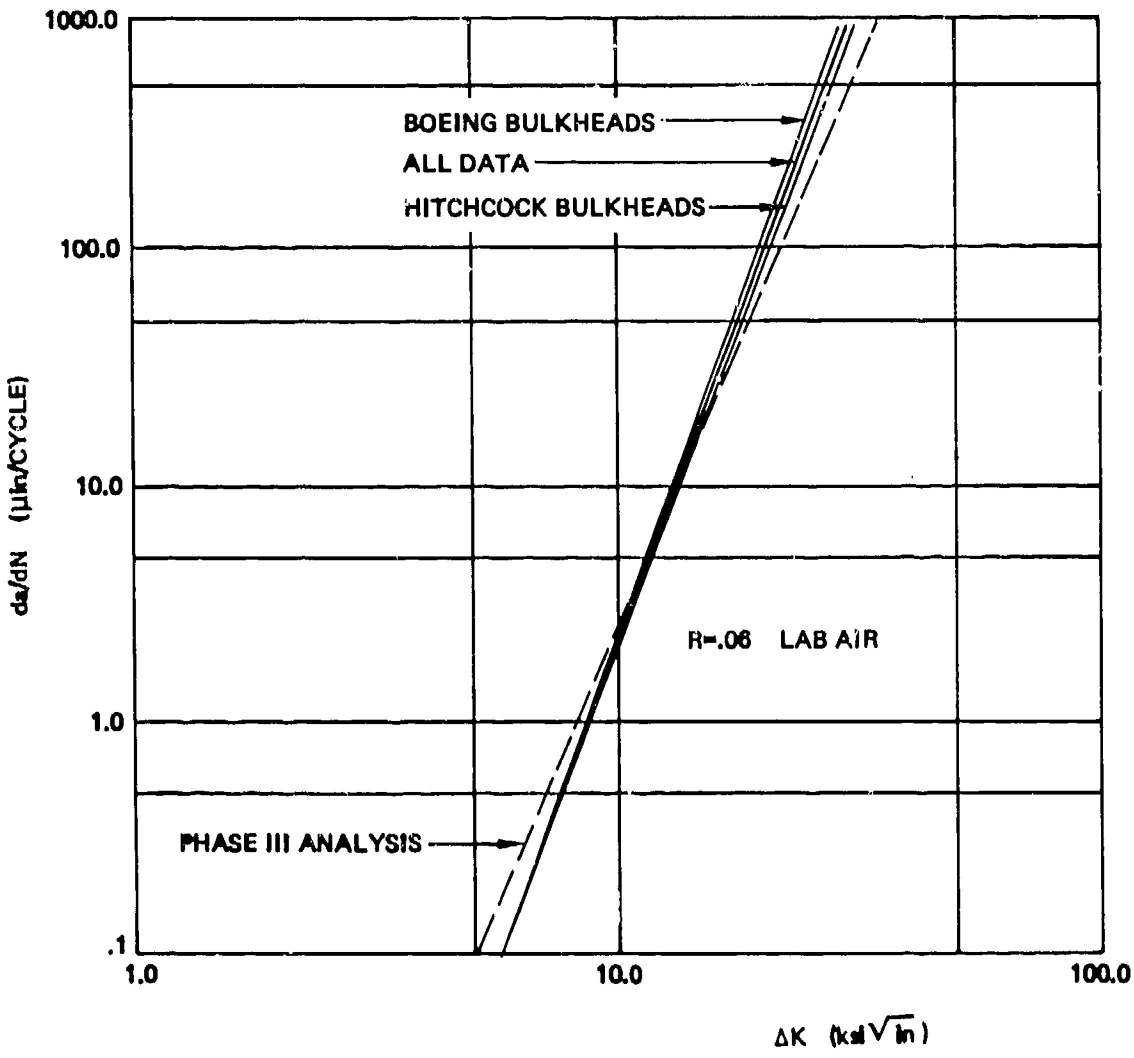

Figure 9. Comparison of Crack Growth Rates

Overall, it is gratifying to see the agreement between the separately cast specimen data and the bulkhead data. This demonstrates that useful crack growth rate data can be obtained from separately cast material.

4. FRACTURE TOUGHNESS TEST RESULTS

Plane-strain fracture toughness tests were conducted according to ASTM standard test method (ref. 7). The compact-type specimen geometry (Fig. 10) was used. The specimens were located on the attachment lugs as shown in Figure 11. These lugs were heavily chilled to obtain optimum properties. All tests were conducted in laboratory air environment. The laboratory test results are contained in Appendix B. The crack front of all specimens exhibited too much curvature according to reference 7 and, for that reason, no valid plane-strain fracture toughness (K_{IC}) data were obtained. The data are henceforth referred to as K_Q data. An examination of the data (Table 4) shows that the results fall into one of three categories:

1. Failure during fatigue cracking (specimens CH9L1, C9L1, C9L8)
2. Lower K_Q values compared to item 3 (specimens CHL1, CH9L2, CH9L7)
3. Consistently good K_Q results for the remaining specimens

The fracture surfaces of the specimens were examined under an optical microscope at 30X magnification. Specimens of category 2 showed more microshrinkage than specimens of category 3. Category 1 specimens had noticeably more microshrinkage and the size of these defects was larger compared to the other specimens. Thus, the amount and sizes of the defects correlate with the test results, as expected. Considering average K_Q values for the individual bulkheads and ignoring the ones with prematurely failed specimens, it is found that bulkhead number M08 had slightly better fracture toughness in the lug areas than bulkhead No. 2. Bulkhead No. 9 exhibited the lowest fracture toughness. Records of the process variables for the individual bulkheads do not offer any clues to this relative ranking in fracture toughness.

Residual strength analysis was conducted during Phase III of the CAST program. An average K_{IC} value of 17.6 ksi in.$^{1/2}$ was used with a lower bound of 16 ksi in.$^{1/2}$. These values were derived from some valid K_{IC} tests conducted earlier in the CAST program. Since the crack front curvature of the bulkhead

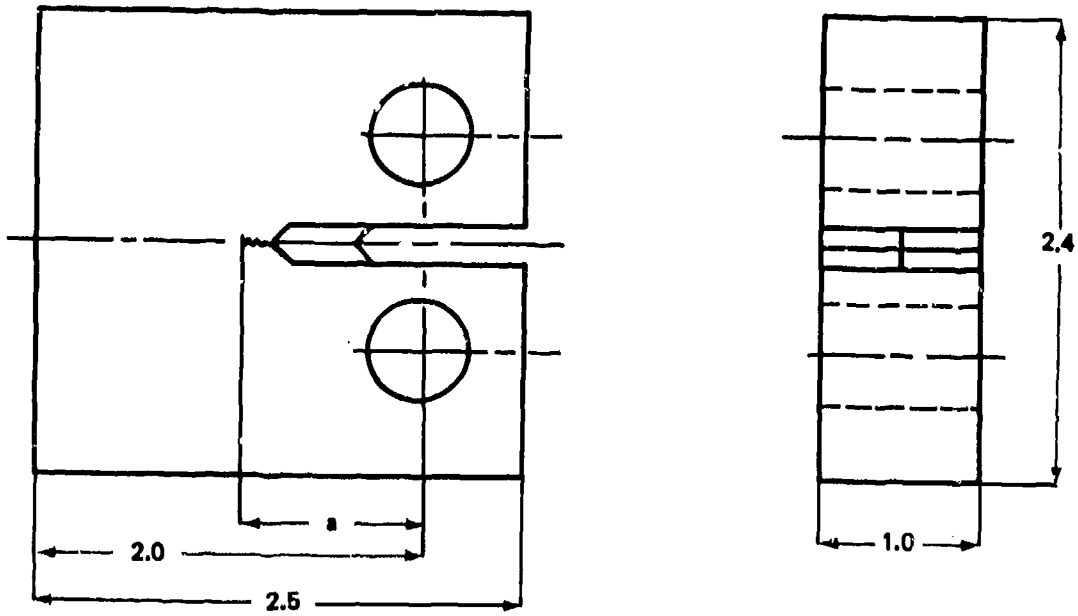

Figure 10. Fracture Toughness Test Specimen

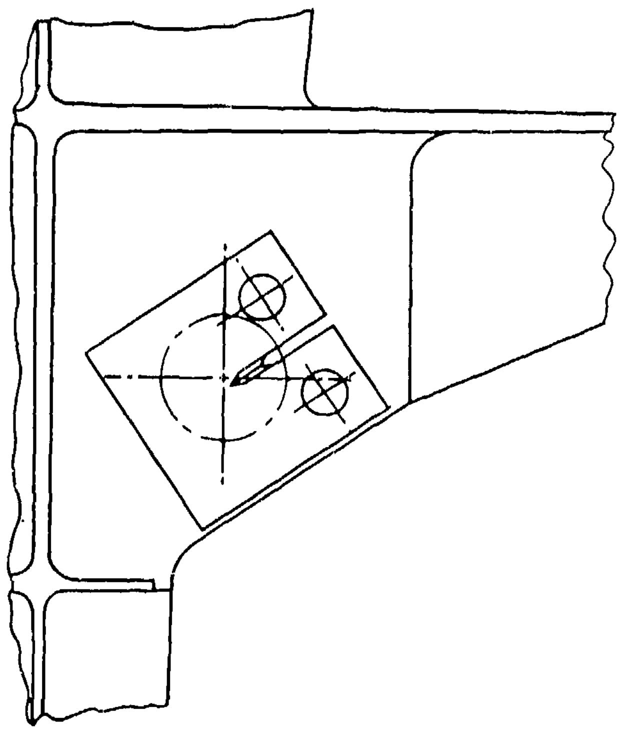

Figure 11. Location of Fracture Toughness Specimens

Table 4. Fracture Toughness Test Results

Specimen ID	K_Q ksi $\sqrt{in}$
CH2L1	21.6
CH2L2	20.8
CH2L7	19.7
CH2L8	20.6
CH9L1	18.3
CH9L2	18.7
CH9L7	13.9
CH9L8	Precrack Failure
C8L1	24.4
C8L2	20.5
C8L7	20.6
C8L8	20.0
C9L1	Precrack Failure
C9L2	21.4
C9L7	21.6
C9L8	Precrack Failure

specimens is not too severe, it can be assumed that the K_Q values obtained are close to valid K_{IC} values. The average K_{IC} value used in the phase III analyses is thus confirmed. However, a lower bound of 16 ksi $in^{1/2}$ appears too optimistic in light of this investigation. The independent specimen data yielded K_Q values from 23.7 to 26.8 ksi $in.^{1/2}$ with an average K_Q of 26.1 ksi $in.^{1/2}$. However, these data exhibited too much yielding $(2.5(K_Q/TYS)^2\ B)$ and, therefore, cannot be assumed to be close to K_{IC}. Therefore, a comparison of the bulkhead data with the separately cast specimen data is not possible.

SECTION III
CONCLUSIONS AND RECOMMENDATIONS

The fatigue and fracture property data obtained from four full-scale A357 cast aluminum alloy bulkheads (two each from the Boeing and Hitchcock foundries) confirmed, in general, the material properties assumed for the Phase III durability and damage tolerance analysis. The data also are in general agreement with property data obtained from specimens that were machined from separately cast plates and blocks. The low fracture toughness values obtained from two of the castings also point out that a need exists for continued development of this casting technology. In particular, a need exists to develop the nondestructive evaluation of fatigue and fracture properties of castings. For castings to be used in primary aircraft structure, it is absolutely necessary to know the lower bound fracture toughness with a high degree of confidence.

The need for nondestructive evaluation of casting mechanical properties was recognized earlier in the CAST program, and a promising method has been developed for tensile properties and further improvements are planned. It is recommended that the nondestructive evaluation of fatigue and fracture properties of castings also be developed.

REFERENCES

1. Test Report, General Material Property Data, CAST Program, Boeing Document D180-20159; and Cast Aluminum Structures Technology (CAST), Technical Bulletin No. 13, January 1979.
2. AFFDL-TR-79-3029, Cast Aluminum Structures Technology (CAST), Phase IV, Fabrication of Demonstration Articles and Production Hardware, March 1979.
3. AFWAL-TR-80-3021, Part III, Cast Aluminum Structures Technology, Phase V (CAST); and Cast Aluminum Structures Technology (CAST), Technical Bulletin No. 15, November 1979.
4. ANSI/ASTM E466-76, Standard Recommended Practice for Constant Amplitude Axial Fatigue Tests of Metallic Materials.
5. AFFDL-TR-78-7, Cast Aluminum Structures Technology, Phase III (CAST), January 1978.
6. ASTM E647-78T, Tentative Test Method for Constant-Load Amplitude Fatigue Crack Growth Rates above 10^{-8} m/Cycle.
7. ANSI/ASTM E399-78, Standard Test Method for Plane-Strain Fracture Toughness of Metallic Materials.

APPENDIX A

CRACK GROWTH RATE TEST DATA

Table A-1.1. Crack Growth Data - SEN 83-1

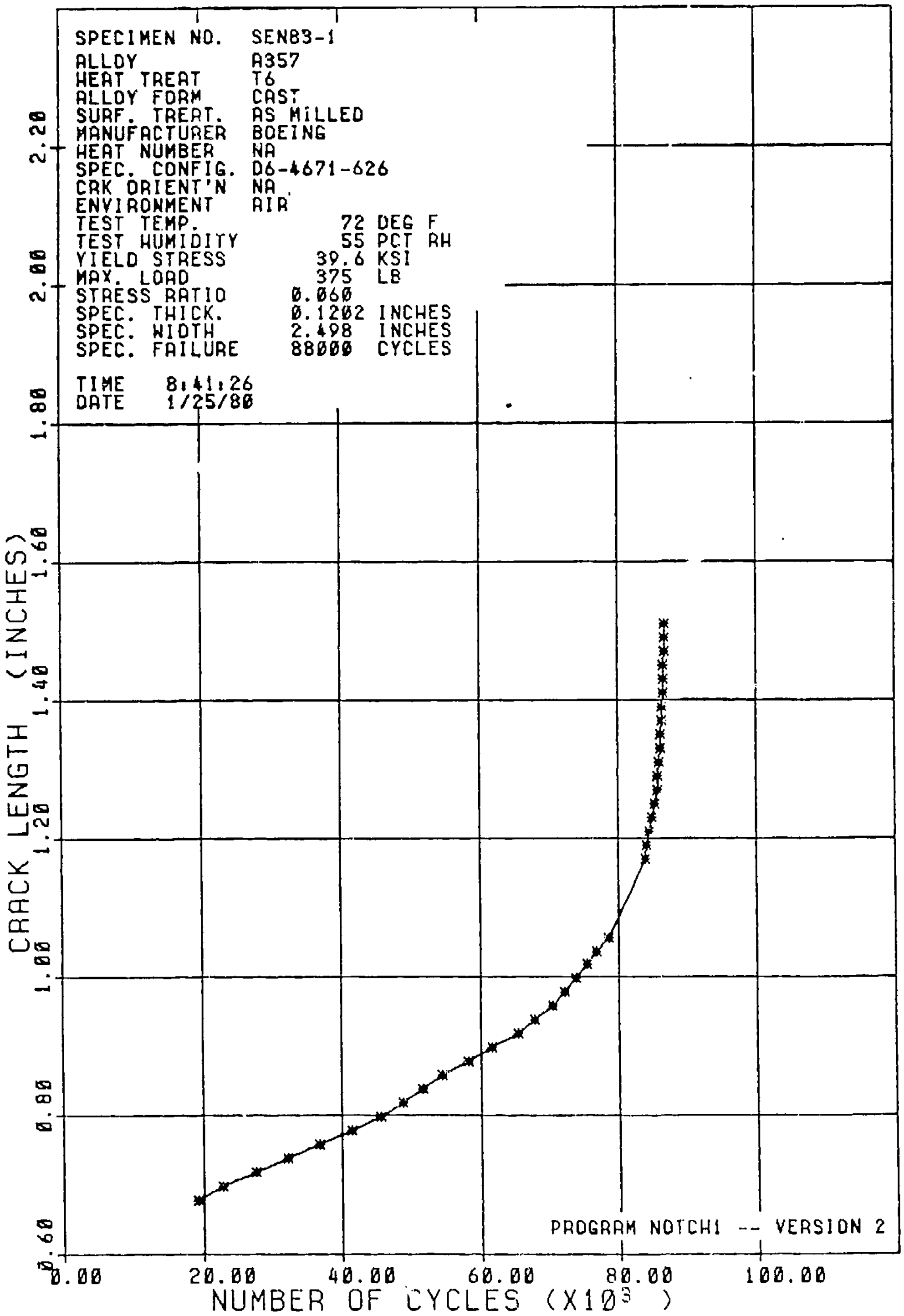

Table A-1.2. Crack Growth Data - SEN 83-1

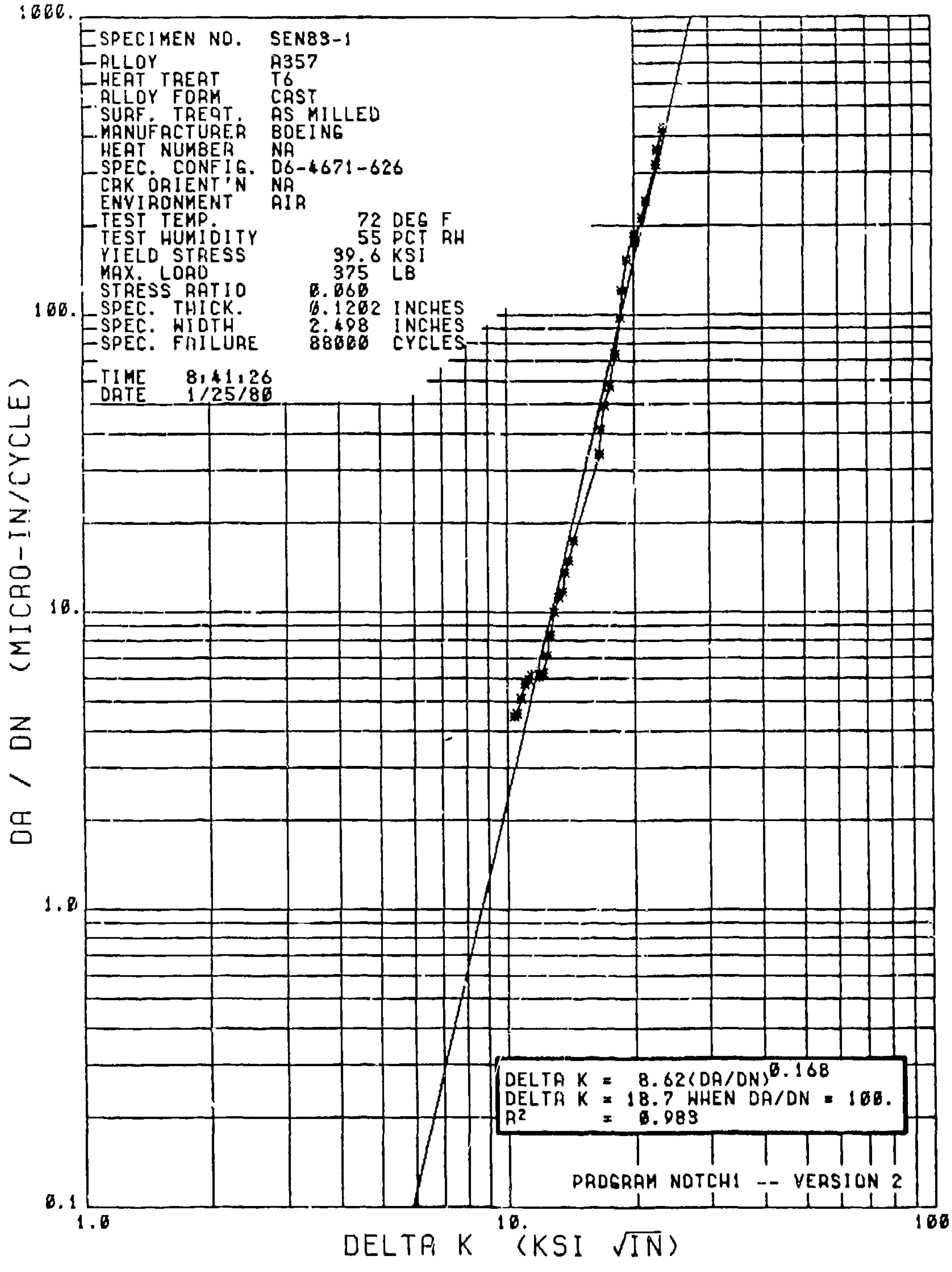

Table A-1.3. Crack Growth Data - SEN 83-1

SPECIMEN NO. SEN83-1

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	72	DEG F
TEST HUMIDITY	55	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.677	INCHES
A21	1.171	INCHES
B	0.1202	INCHES
W	2.498	INCHES
SPEC. FAILURE	88000	CYCLES

TIME 8:41:26
DATE 1/25/80

JOB NO. F1232E

CALC. BY: Ray Dussey DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D. Helm DATE 7/6/80

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*                                      *
*  COMPACT TENSION SPECIMEN            *
*                                      *
*  SEVEN POINT INCREMENTAL POLYNOMIAL  *
*  METHOD FOR DETERMINING DA/DN.       *
*                                      *
*  PROGRAM NOTCH1  --  VERSION NO. 2   *
*                                      *
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GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	10.72	19296.	0.677		
2	12.67	22806.	0.697		
3	15.29	27522.	0.717		
4	17.93	32274.	0.737	10.30	4.461
5	20.45	368[illegible]0.	0.757	10.51	4.583
6	23.04	41472.	0.777	10.74	5.093
7	25.31	45558.	0.797	10.97	5.747
8	27.10	48780.	0.817	11.19	5.926
9	28.65	51570.	0.837	11.40	6.096
10	30.25	54450.	0.857	11.63	6.173
11	32.37	58266.	0.877	11.90	6.069
12	34.25	61650.	0.897	12.13	6.245
13	36.35	65430.	0.917	12.43	7.166
14	37.68	67824.	0.937	12.64	8.389
15	39.10	70380.	0.957	12.94	9.986
16	40.13	72234.	0.977	13.21	11.247
17	40.98	73764.	0.997	13.46	11.650
18	41.88	75384.	1.017	13.72	13.494
19	42.69	76842.	1.037	14.01	14.915
20	43.72	78696.	1.057	14.42	17.492
21	46.67	84006.	1.171	16.62	33.948
22	46.74	84132.	1.191	16.67	40.881
23	46.99	84582.	1.210	17.02	49.383
24	47.24	85032.	1.230	17.53	57.234
25	47.48	85464.	1.250	18.05	73.636
26	47.65	85770.	1.270	18.58	98.327
27	47.70	85860.	1.290	18.76	120.315
28	47.81	86058.	1.310	19.39	152.861
29	47.90	86220.	1.330	20.09	190.319
30	47.92	86256.	1.350	20.28	176.449
31	47.99	86382.	1.370	21.00	211.497
32	48.03	86454.	1.390	21.45	239.672
33	48.11	86598.	1.410	22.60	319.266
34	48.12	86616.	1.430	22.72	357.019
35	48.15	86670.	1.450	23.38	424.163
36	48.18	86724.	1.470	0.00	0.303
37	48.20	86760.	1.490	0.00	0.000
38	48.22	86796.	1.510		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

Table A-2.1. Crack Growth Data - SEN 83-2

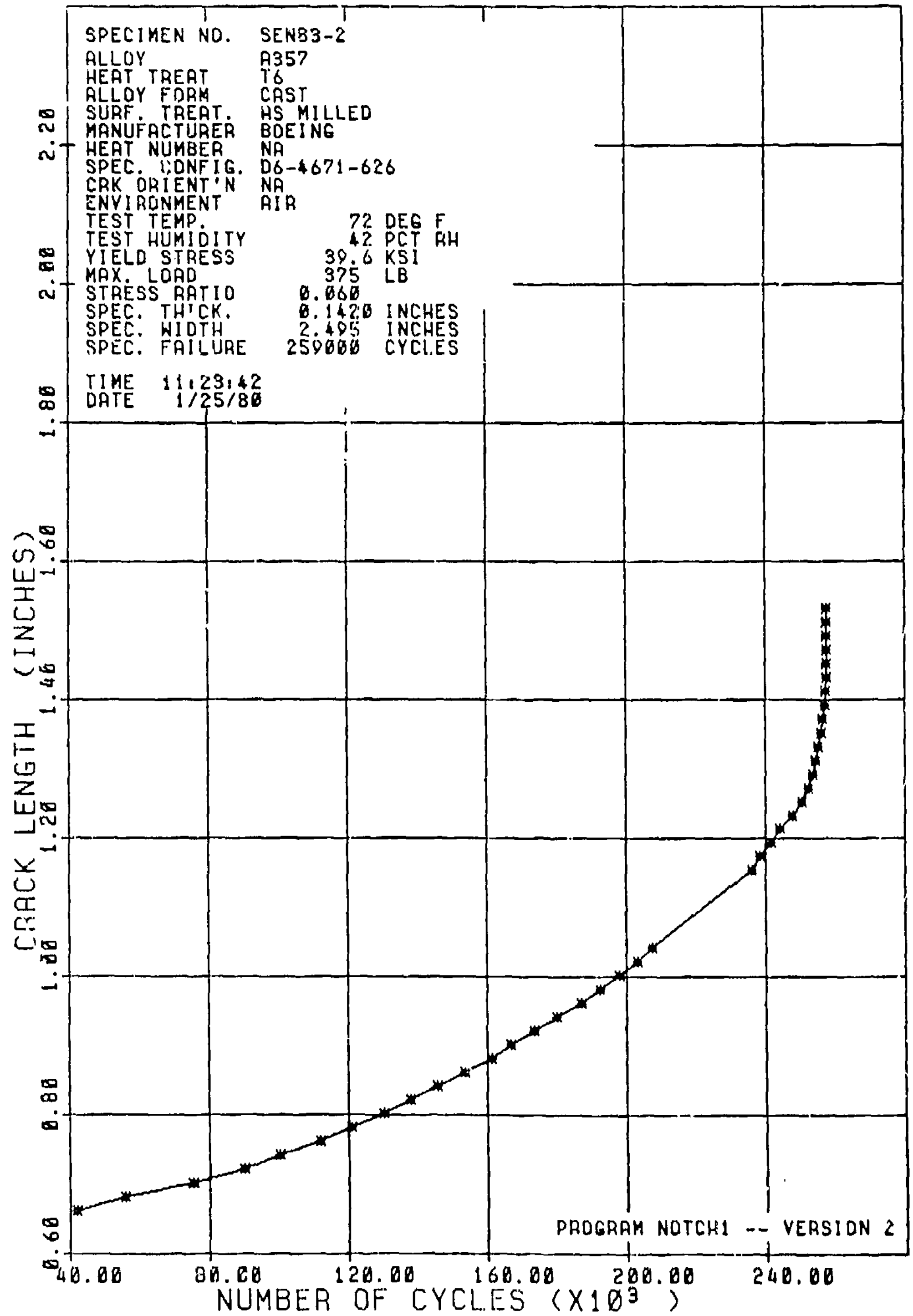


Table A-2.2. Crack Growth Data - SEN 83-2

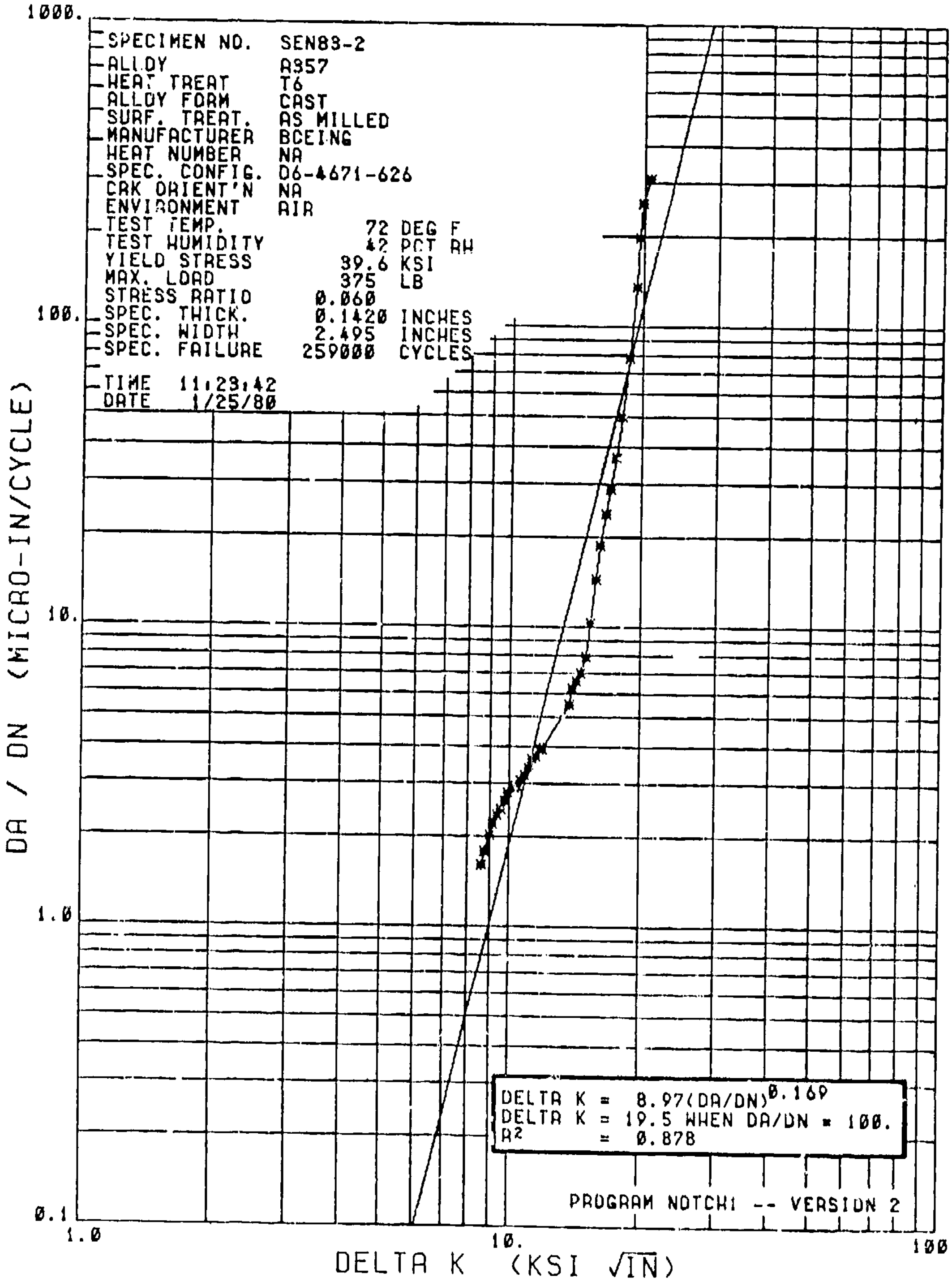


Table A-2.3. Crack Growth Data - SEN 83-2

SPECIMEN NO. SEN83-2

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-625	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	72	DEG F
TEST HUMIDITY	42	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.662	INCHES
A21	1.153	INCHES
B	0.1420	INCHES
W	2.495	INCHES
SPEC. FAILURE	259000	CYCLES

TIME 11:23:42
DATE 1/25/80

JOB NO. F1232E

COMPACT TENSION SPECIMEN

SEVEN POINT INCREMENTAL POLYNOMIAL METHOD FOR DETERMINING DA/DN.

PROGRAM NOTCH1 — VERSION NO. 2

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	23.41	42138.	0.662		
2	31.12	56016.	0.682		
3	41.93	75474.	0.701		
4	49.92	89856.	0.721	8.61	1.602
5	55.75	100350.	0.741	8.76	1.770
6	62.18	111924.	0.761	8.96	2.007
7	67.21	120978.	0.781	9.14	2.193
8	72.44	130392.	0.801	9.34	2.355
9	76.71	138078.	0.821	9.52	2.472
10	80.90	145620.	0.841	9.71	2.625
11	85.26	153468.	0.861	9.93	2.780
12	89.54	161172.	0.881	10.15	2.908
13	92.72	166896.	0.901	10.33	2.936
14	96.45	173610.	0.921	10.55	3.072
15	100.00	180000.	0.941	10.77	3.202
16	104.09	187362.	0.961	11.03	3.378
17	106.88	192384.	0.981	11.23	3.631
18	109.94	197892.	1.001	11.50	3.697
19	112.81	203058.	1.021	11.74	3.952
20	115.16	207288.	1.041	11.93	3.896
21	131.02	235836.	1.153	13.68	5.481
22	132.45	238428.	1.173	13.88	6.217
23	134.12	241416.	1.193	14.19	6.601
24	135.57	244026.	1.213	14.52	7.035
25	137.50	247500.	1.233	14.93	7.935
26	139.02	250236.	1.253	15.33	10.284
27	140.22	252396.	1.273	15.78	14.451
28	140.83	253494.	1.293	16.09	18.646
29	141.42	254556.	1.313	16.51	23.728
30	141.85	255330.	1.333	16.94	28.684
31	142.25	256050.	1.353	17.43	36.426
32	142.55	256590.	1.373	17.94	50.159
33	142.80	257040.	1.393	18.59	78.377
34	142.96	257328.	1.413	19.33	134.956
35	143.00	257400.	1.433	19.56	197.834
36	143.04	257472.	1.453	19.92	256.089
37	143.09	257562.	1.473	20.74	308.911
38	143.13	257634.	1.493		
39	143.15	257670.	1.513		
40	143.18	257724.	1.533		

CALC. BY: Ray Durny DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D. Walker DATE 3/6/80

Table A-3.1. Crack Growth Data - SEN 85-1

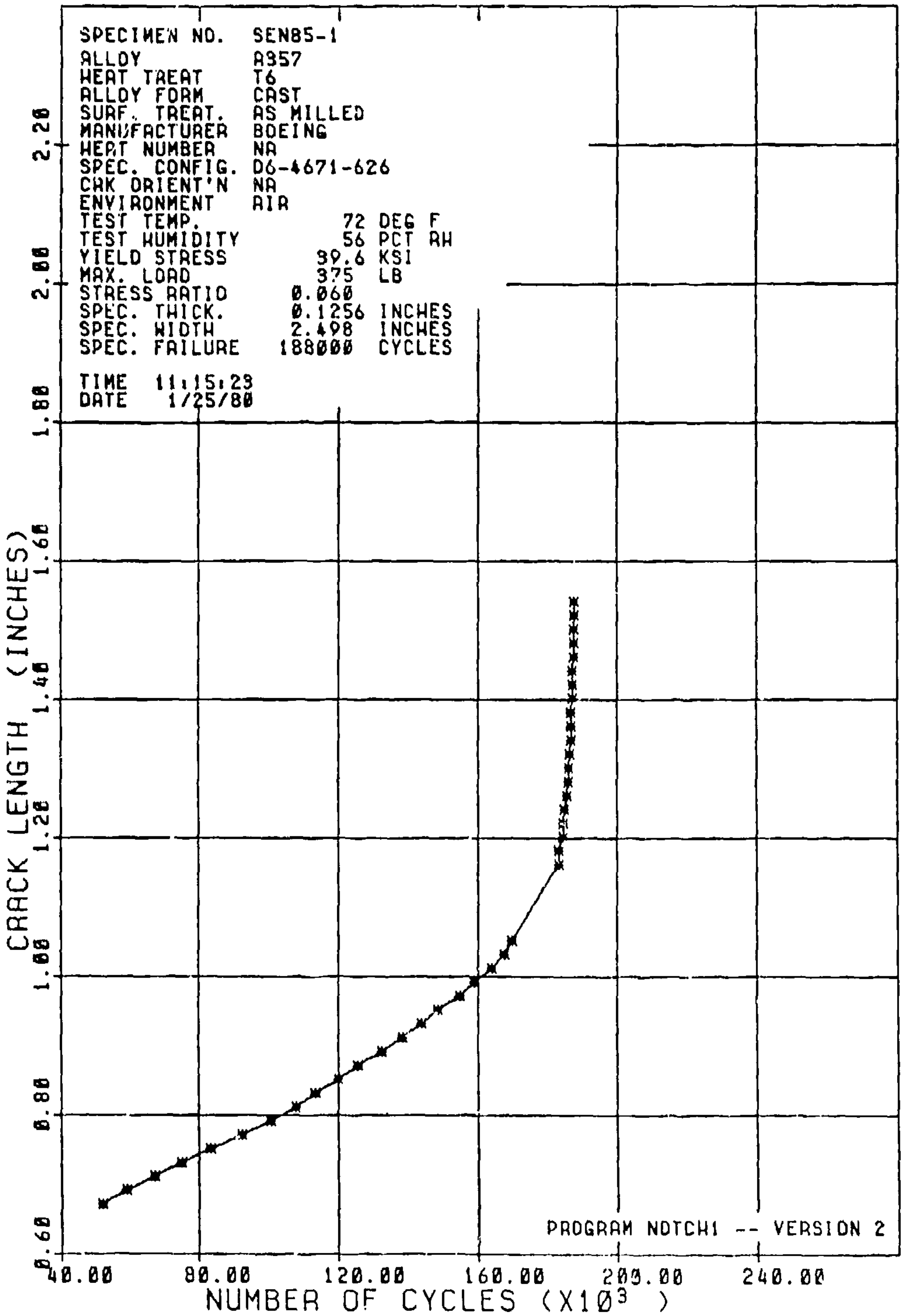
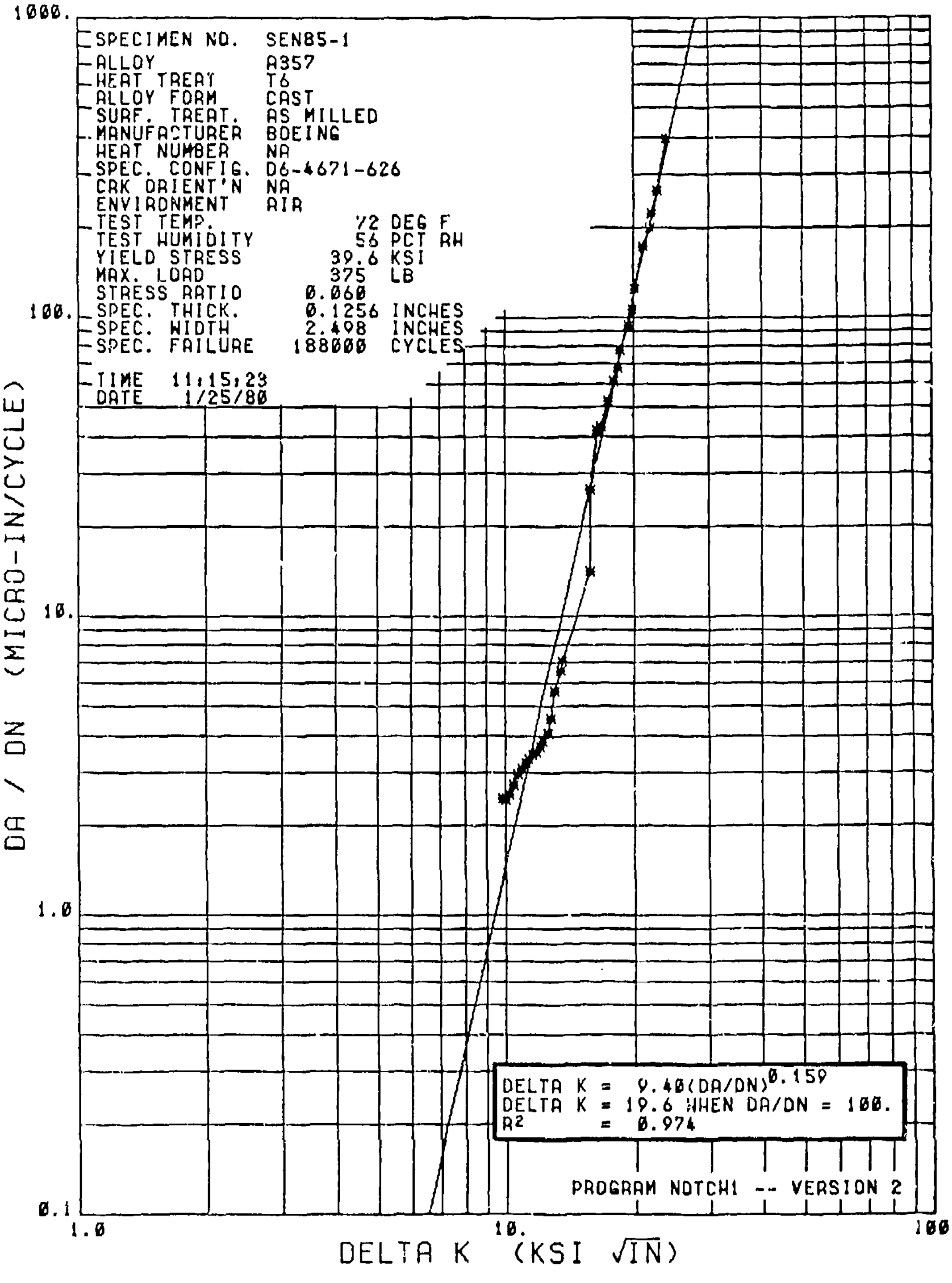


Table A-3.2. Crack Growth Data - SEN 85-1



SPECIMEN NO. SEN85-1

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	72	DEG F
TEST HUMIDITY	56	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.672	INCHES
A21	1.161	INCHES
B	0.1256	INCHES
W	2.438	INCHES
SPEC. FAILURE	188000	CYCLES

TIME 11:15:23
DATE 1/25 80

JOB NO. F1232E

CALC. BY: Ray Pucur DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D. Wilson DATE 3/6/80

COMPACT TENSION SPECIMEN

SEVEN POINT INCREMENTAL POLYNOMIAL
METHOD FOR DETERMINING DA/DN.

PROGRAM NOTCH1 — VERSION NO. 2

Table A-3.3. Crack Growth Data - SEN 85-1

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	28.81	51858.	0.672		
2	32.76	58968.	0.692		
3	37.38	67284.	0.711		
4	41.66	74988.	0.731	9.80	2.454
5	46.17	83106.	0.751	9.99	2.422
6	51.30	92340.	0.771	10.22	2.528
7	55.96	100728.	0.791	10.44	2.736
8	59.96	107928.	0.811	10.65	2.972
9	63.20	113760.	0.831	10.86	3.103
10	66.60	119882.	0.851	11.09	3.216
11	69.88	125784.	0.871	11.31	3.322
12	73.50	132300.	0.891	11.56	3.452
13	76.94	138492.	0.911	11.82	3.504
14	79.69	143442.	0.931	12.04	3.670
15	82.38	148284.	0.951	12.27	3.810
16	85.96	154728.	0.971	12.59	4.056
17	88.16	158688.	0.991	12.79	4.559
18	91.10	163980.	1.011	13.13	5.505
19	93.21	167778.	1.031	13.44	6.609
20	94.26	169668.	1.051	13.60	7.106
21	101.70	183060.	1.161	15.34	14.115
22	101.85	183330.	1.181	15.88	26.603
23	102.35	184230.	1.201	16.40	42.169
24	102.43	184374.	1.221	16.54	41.689
25	102.65	184770.	1.241	16.84	42.809
26	103.00	185400.	1.261	17.47	52.065
27	103.27	185886.	1.281	18.02	60.882
28	103.40	186120.	1.301	18.34	67.712
29	103.49	186282.	1.321	18.62	77.647
30	103.70	186660.	1.341	19.45	93.458
31	103.82	186876.	1.361	19.97	107.034
32	103.87	186966.	1.381	20.21	124.664
33	103.99	187182.	1.401	21.09	171.725
34	104.07	187326.	1.421	21.88	200.303
35	104.09	187362.	1.441	22.08	220.569
36	104.13	187434.	1.461	22.67	265.437
37	104.20	187560.	1.481	24.00	395.164
38	104.22	187596.	1.501		
39	104.24	187632.	1.521		
40	104.25	187650.	1.541		

Table A-4.1. Crack Growth Data - SEN 85-2

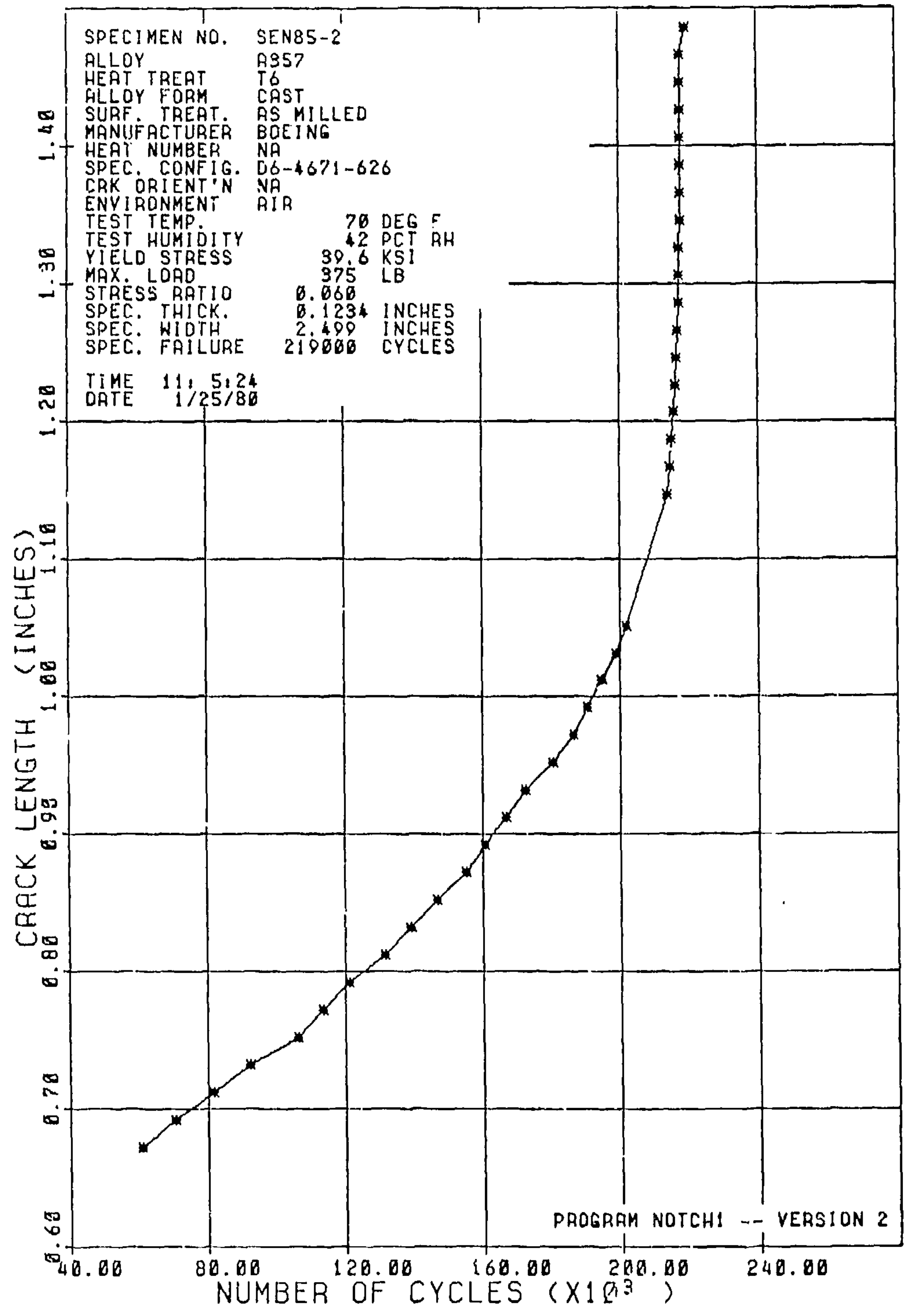


Table A-4.2. Crack Growth Data - SEN 85-2

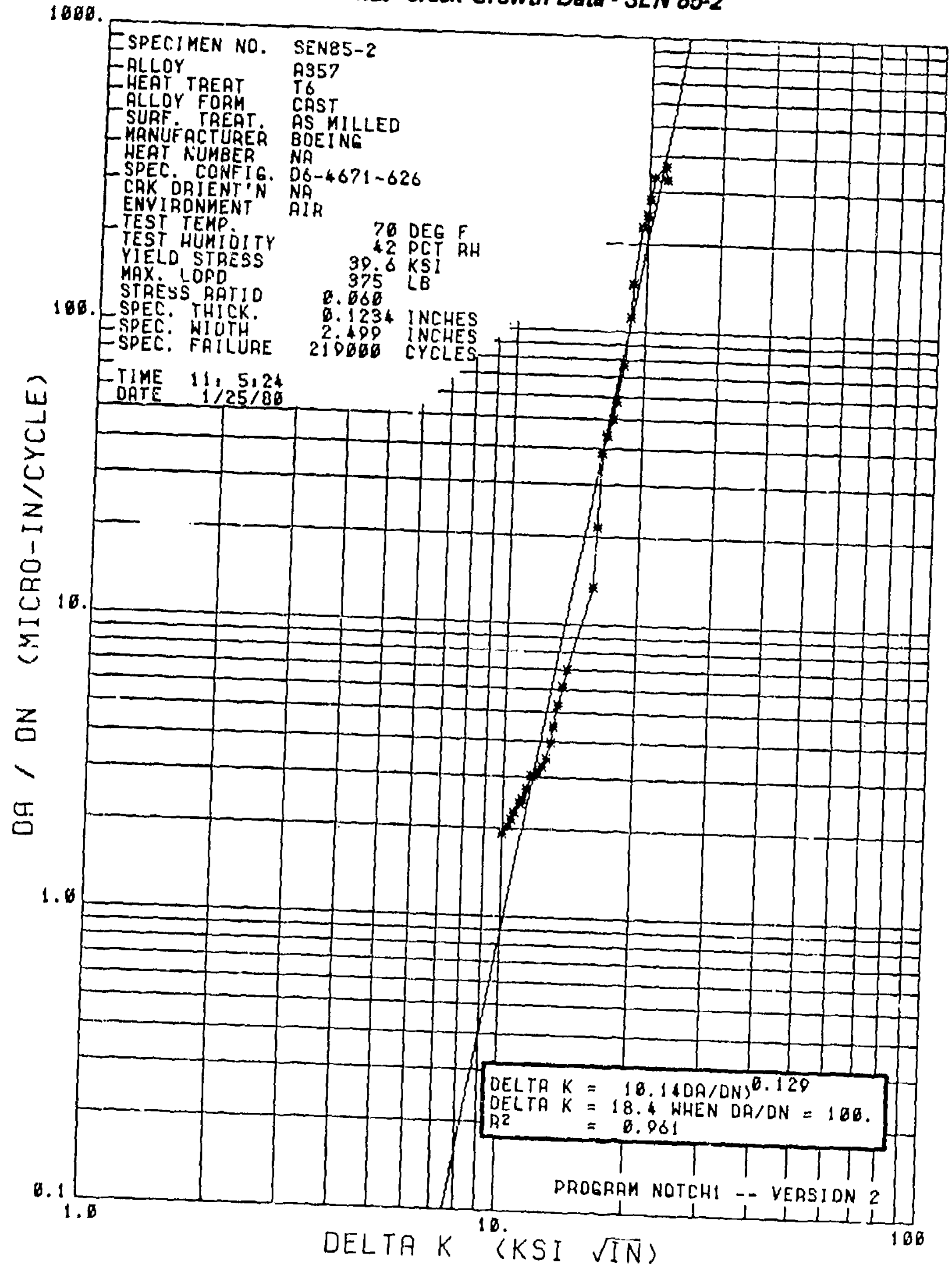


Table A-4.3. Crack Growth Data - SEN 85-2

SPECIMEN NO. SEN85-2

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	70	DEG F
TEST HUMIDITY		PCT RH
YIELD STRESS	[illegible]	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.672	INCHES
A21	1.147	INCHES
B	0.1234	INCHES
W	2.499	INCHES
SPEC. FAILURE	219000	CYCLES

TIME 11:5:24
DATE 1/25/80

JOB NO. F1232E

COMPACT TENSION SPECIMEN

SEVEN POINT INCREMENTAL POLYNOMIAL METHOD FOR DETERMINING DA/DN.

PROGRAM NOTCH1 — VERSION NO. 2

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	33.88	60984.	0.672		
2	39.11	70398.	0.692		
3	45.38	81684.	0.711		
4	51.35	92430.	0.731	9.95	1.914
5	59.15	106470.	0.751	10.23	2.041
6	63.14	113652.	0.771	10.38	2.152
7	67.36	121248.	0.791	10.56	2.269
8	73.13	131634.	0.811	10.85	2.423
9	77.27	139086.	0.831	11.04	2.518
10	81.66	146988.	0.851	11.27	2.722
11	86.23	155214.	0.871	11.54	3.035
12	89.28	160704.	0.891	11.75	3.027
13	92.68	166824.	0.911	11.99	3.111
14	95.68	172224.	0.931	12.21	3.265
15	100.12	180216.	0.951	12.53	3.485
16	103.51	186318.	0.971	12.80	3.956
17	105.93	190674.	0.991	13.03	4.486
18	108.24	194832.	1.011	13.30	5.267
19	110.50	198900.	1.031	13.62	6.130
20	112.31	202158.	1.051	13.90	6.982
21	118.99	214182.	1.147	15.78	13.414
22	119.37	214866.	1.167	15.99	21.409
23	119.66	215388.	1.186	16.19	38.561
24	119.98	215964.	1.206	16.60	44.050
25	120.25	216450.	1.226	17.05	50.070
26	120.37	216666.	1.246	17.27	57.767
27	120.63	217134.	1.266	17.91	77.190
28	120.80	217440.	1.286	18.47	112.236
29	120.85	217530.	1.306	18.69	146.500
30	120.95	217710.	1.326	19.42	225.401
31	121.00	217800.	1.346	19.95	249.070
32	121.02	217836.	1.366	20.18	281.413
33	121.05	217890.	1.386	20.69	336.389
34	121.11	217998.	1.406	21.87	366.811
35	121.12	218016.	1.426	22.16	328.435
36	121.14	218052.	1.446	0.00	0.000
37	121.18	218124.	1.466	0.00	0.000
38	122.00	219600.	1.486		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

CALC. BY: R. E. Dunning DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 1-20-79

APRD. BY: D. Nels DATE 3/6/80

Table A-5.1. Crack Growth Data - SEN 93-1

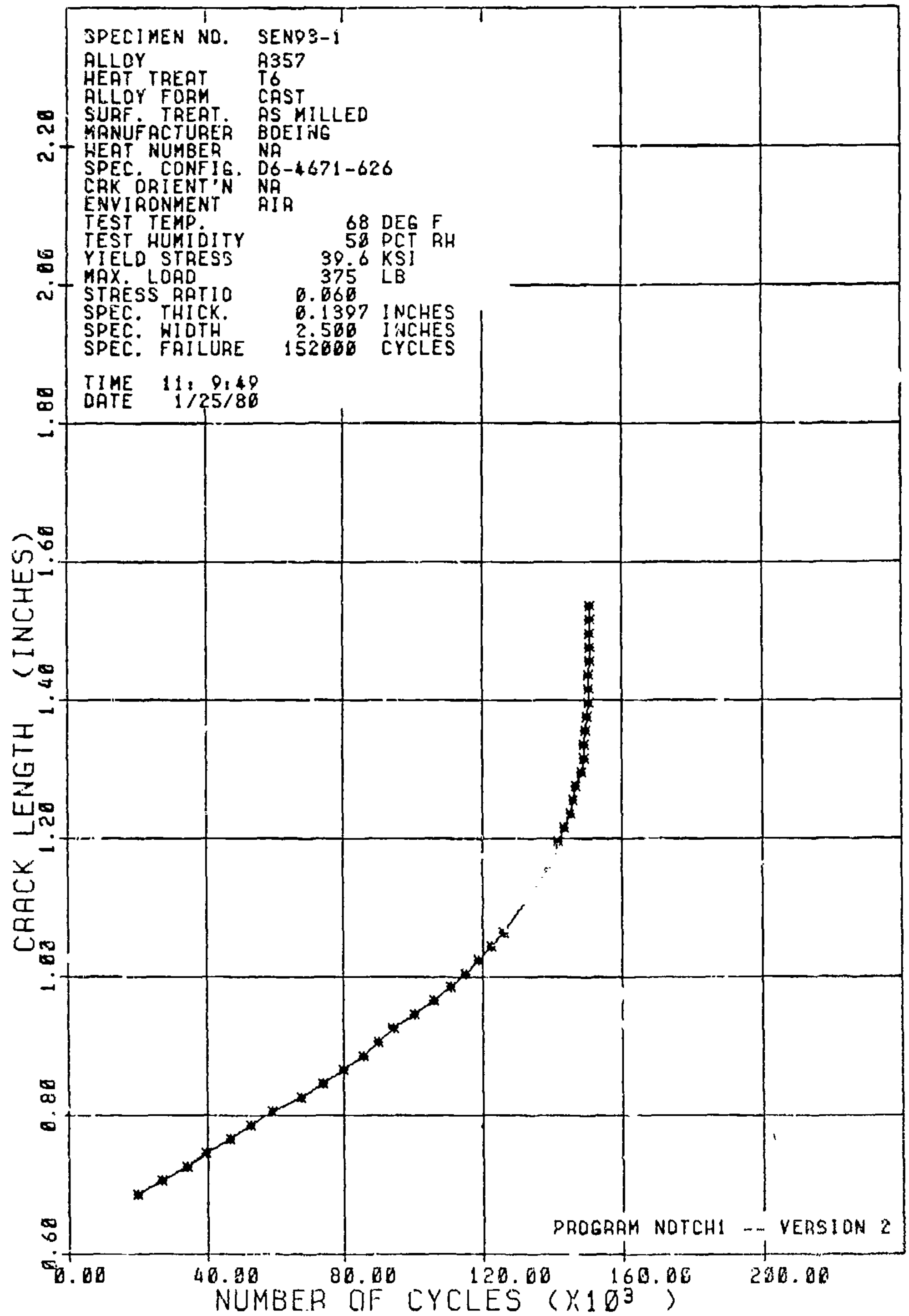


Table A-5.2. Crack Growth Data - SEN 93-1

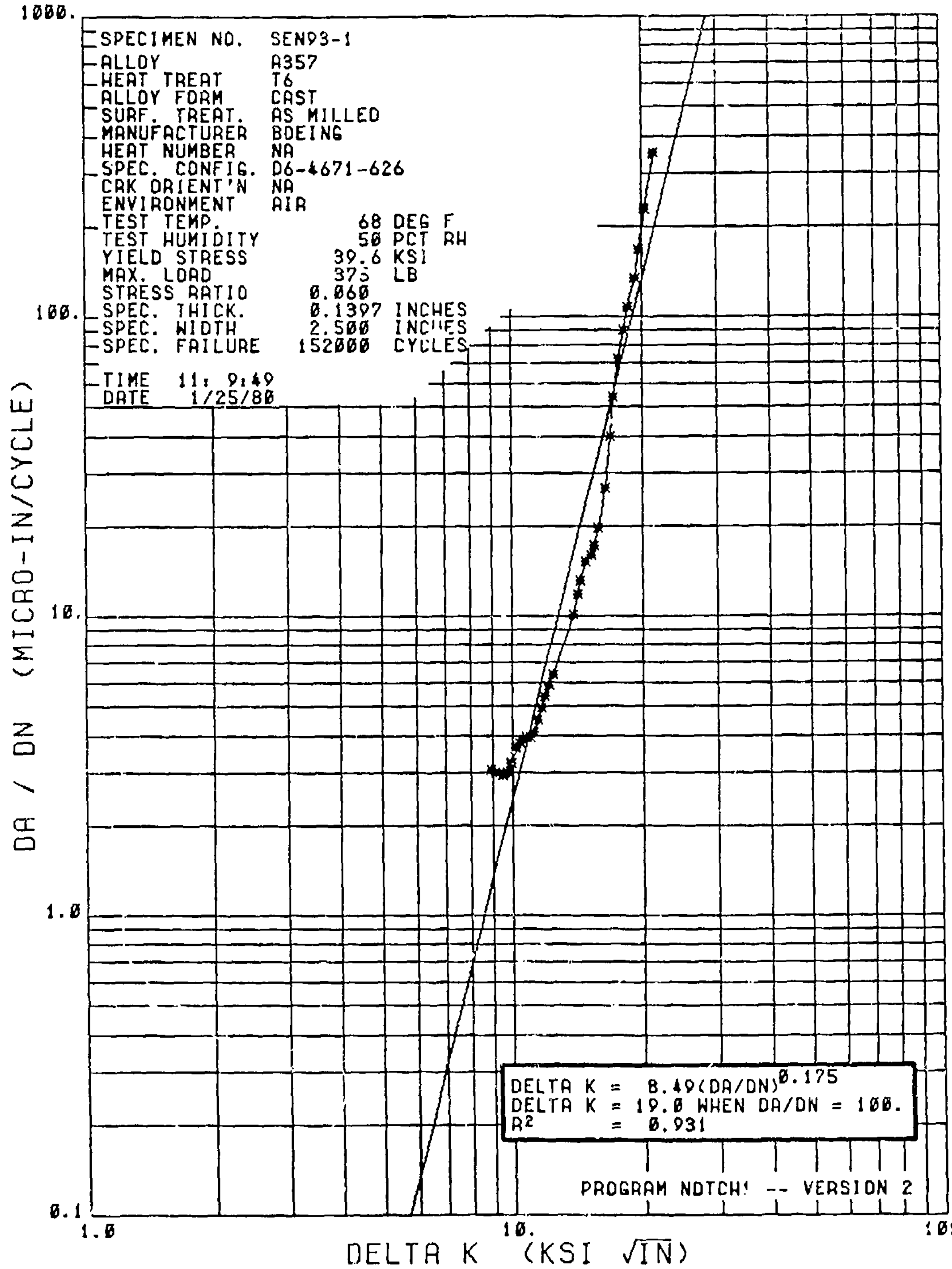


Table A-5.3. Crack Growth Data - SEN 93-1

SPECIMEN NO. SEN93-1

ALLOY	A357		
HEAT TREAT	T6		
ALLOY FORM	CAST		
SURF. TREAT.	AS MILLED		
MANUFACTURER	BOEING		
HEAT NUMBER	NA		
SPEC. CONFIG.	D6-4671-626		
CRK ORIENT'N	NA		
ENVIRONMENT	AIR		
TEST TEMP.		68	DEG F
TEST HUMIDITY		50	PCT RH
YIELD STRESS		39.6	KSI
MAX. LOAD		375.	LB
CYCLIC RATE		1800.	CPM
STRESS RATIO		0.060	
CHART SPEED		1.00	IN/MIN
GRID SPACING		0.020	INCHES
A1		0.685	INCHES
A21		1.156	INCHES
B		0.1397	INCHES
W		2.500	INCHES
SPEC. FAILURE		152000	CYCLES

TIME 11:9:49
DATE 1/25/80

JOB NO. F1232E

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*                                      *
* COMPACT TENSION SPECIMEN             *
*                                      *
* SEVEN POINT INCREMENTAL POLYNOMIAL   *
* METHOD FOR DETERMINING DA/DN.        *
*                                      *
* PROGRAM NOTCH1 -- VERSION NO. 2      *
*                                      *
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GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	11.06	19908.	0.685		
2	14.78	26604.	0.705		
3	18.86	33948.	0.725		
4	22.05	39690.	0.745	8.91	3.066
5	25.98	46764.	0.765	9.12	3.004
6	29.37	52866.	0.785	9.30	2.992
7	32.78	59004.	0.805	9.47	2.941
8	37.54	67572.	0.825	9.71	3.010
9	41.07	73926.	0.845	9.89	3.240
10	44.51	80118.	0.865	10.10	3.615
11	47.66	85788.	0.885	10.33	3.779
12	50.02	90036.	0.905	10.51	3.844
13	52.53	94554.	0.925	10.71	3.931
14	55.88	100584.	0.945	10.98	3.950
15	58.78	105804.	0.965	11.20	4.100
16	61.60	110880.	0.985	11.44	4.503
17	64.06	115308.	1.005	11.69	4.972
18	66.04	118872.	1.026	11.92	5.373
19	68.04	122472.	1.045	12.18	5.886
20	69.94	125892.	1.065	12.44	6.387
21	77.14	138852.	1.156	13.89	10.072
22	78.15	140670.	1.176	14.18	11.855
23	78.65	141570.	1.196	14.35	13.136
24	79.66	143388.	1.216	14.78	15.163
25	80.56	145008.	1.236	15.25	16.051
26	81.09	145962.	1.256	15.53	17.180
27	81.51	146718.	1.276	15.79	19.746
28	82.37	148266.	1.296	16.47	26.788
29	82.79	149022.	1.316	16.90	39.883
30	82.98	149364.	1.336	17.20	53.833
31	83.22	149796.	1.356	17.76	72.463
32	83.36	150048.	1.376	18.22	89.796
33	83.45	150210.	1.396	18.58	107.555
34	83.58	150444.	1.416	19.32	133.589
35	83.65	150570.	1.436	19.80	167.300
36	83.71	150678.	1.456	20.36	229.105
37	83.78	150804.	1.476	21.40	351.202
38	83.80	150840.	1.496		
39	83.81	150858.	1.516		
40	83.84	150912.	1.536		

CALC. BY: Ray Denny DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D. Ruhe DATE 3/6/80

Table A-6.1. Crack Growth Data - SEN 93-2

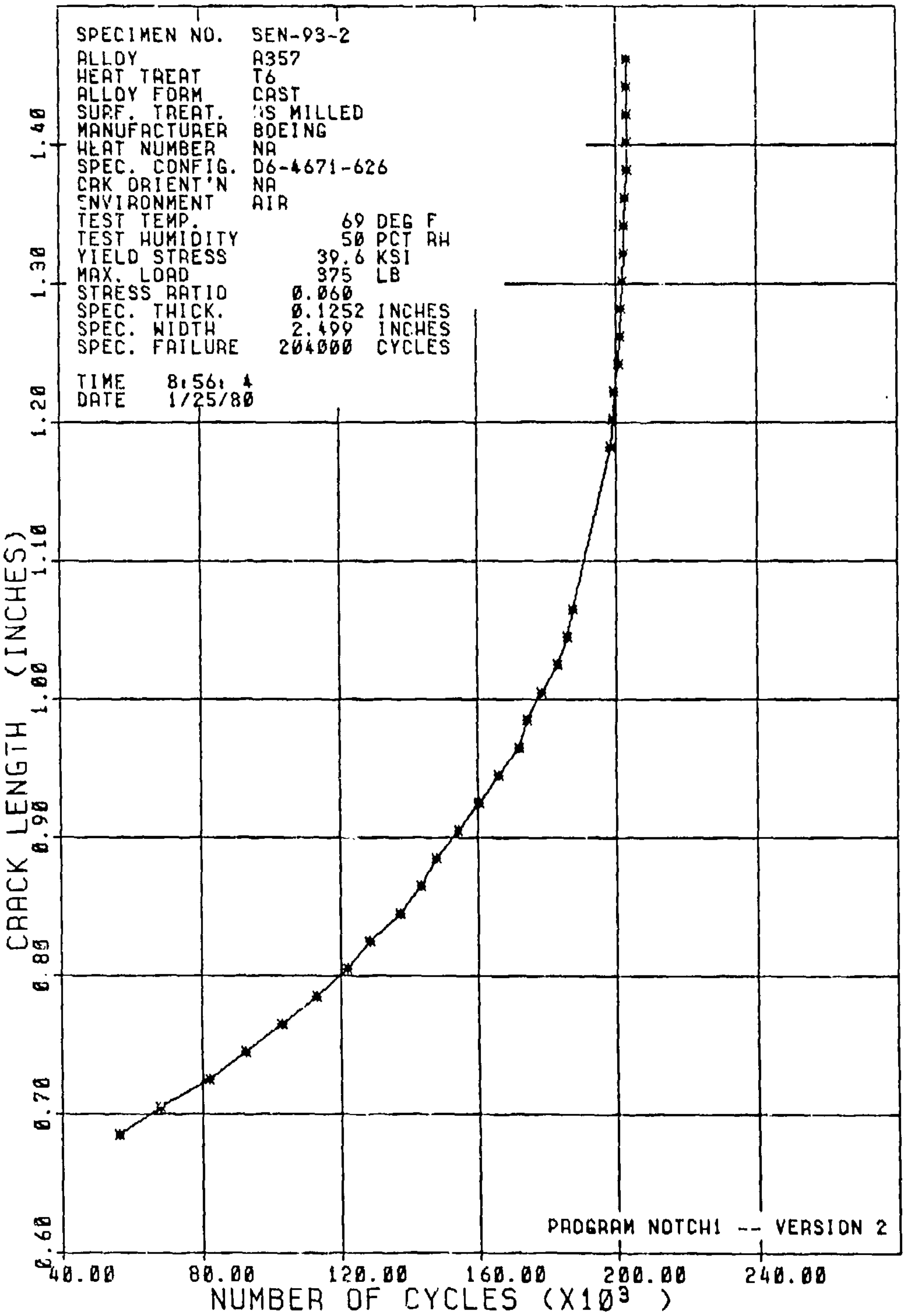

Table A-6.2. Crack Growth Data - SEN 93-2

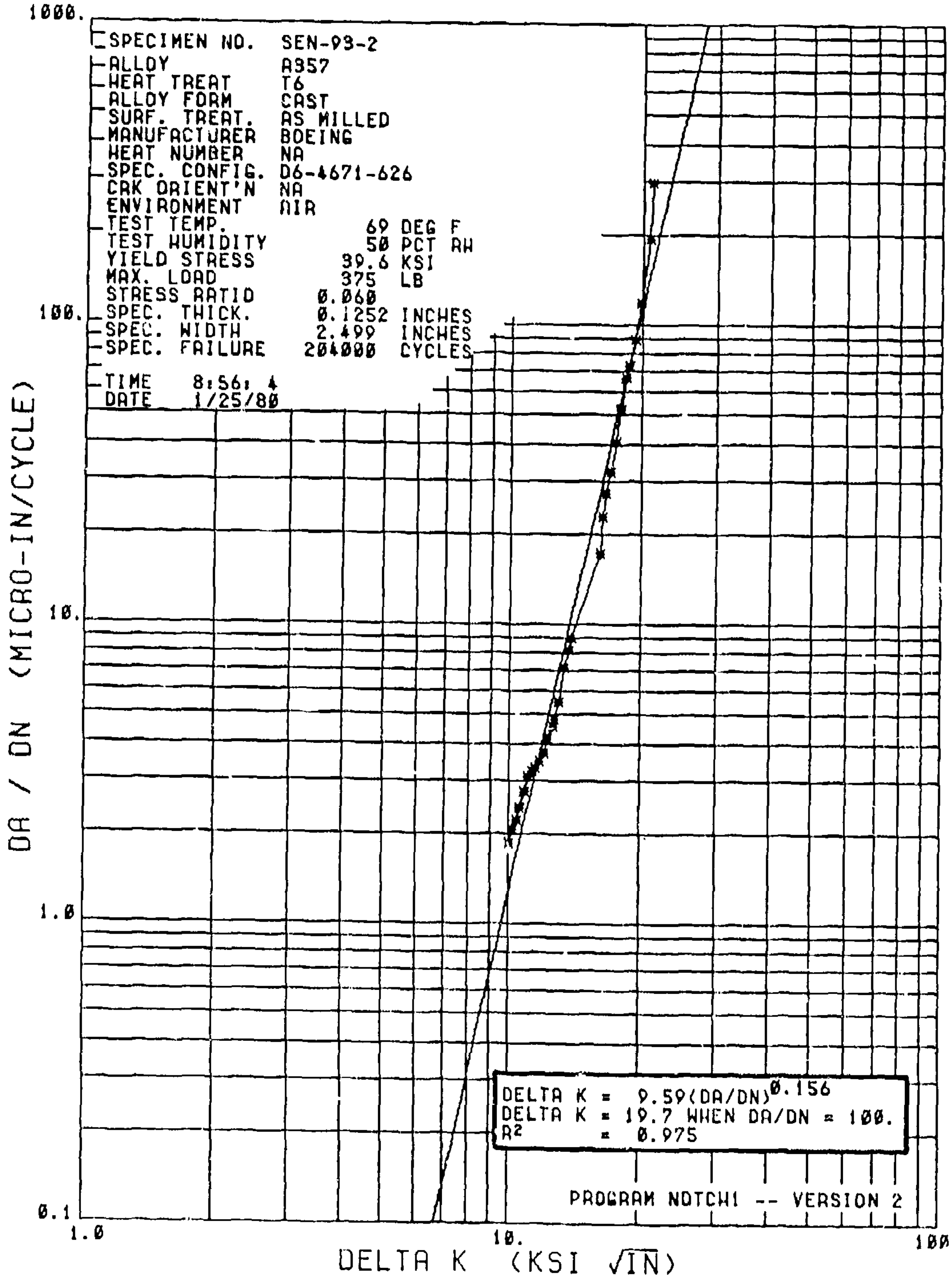

Table A-6.3. Crack Growth Data - SEN 93-2

SPECIMEN NO. SEN-93-2
****

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	69	DEG F
TEST HUMIDITY	50	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.685	INCHES
A21	1.182	INCHES
B	0.1252	INCHES
W	2.499	INCHES
SPEC. FAILURE	204000	CYCLES

TIME 8:56:4
DATE 1/25/80

JOB NO. F1232E

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*****************************************
*                                       *
*  COMPACT TENSION SPECIMEN             *
*                                       *
*  SEVEN POINT INCREMENTAL POLYNOMIAL   *
*  METHOD FOR DETERMINING DA/DN.        *
*                                       *
*  PROGRAM NOTCH1  —  VERSION NO. 2     *
*                                       *
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GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	31.25	56250.	0.685		
2	37.88	68184.	0.705		
3	45.59	82062.	0.725		
4	51.66	92988.	0.745	9.96	1.856
5	57.41	103338.	0.765	10.16	2.057
6	62.90	113220.	0.785	10.39	2.226
7	67.76	121968.	0.805	10.61	2.444
8	71.62	128916.	0.825	10.79	2.753
9	76.49	137682.	0.845	11.08	3.096
10	79.70	143460.	0.865	11.29	3.222
11	82.15	147870.	0.885	11.46	3.309
12	85.74	154332.	0.905	11.75	3.477
13	89.21	160578.	0.925	12.00	3.696
14	92.31	166158.	0.945	12.24	4.171
15	95.58	172044.	0.965	12.58	4.556
16	96.78	174204.	0.985	12.71	4.787
17	99.06	178308.	1.005	12.99	5.511
18	101.78	183204.	1.025	13.36	7.163
19	103.41	186138.	1.045	13.66	8.214
20	104.32	187776.	1.065	13.84	8.992
21	110.15	198270.	1.182	16.07	17.293
22	110.58	199044.	1.202	16.30	22.964
23	110.89	199602.	1.222	16.54	27.441
24	111.45	200610.	1.242	17.12	32.172
25	111.78	201204.	1.262	17.51	40.560
26	112.03	201654.	1.282	17.92	52.306
27	112.28	202104.	1.302	18.49	66.754
28	112.40	202320.	1.322	18.84	73.278
29	112.53	202554.	1.342	19.30	89.111
30	112.67	202806.	1.362	19.95	117.695
31	112.80	203040.	1.382	20.85	193.268
32	112.83	203094.	1.402	21.16	298.184
33	112.87	203166.	1.422	0.00	0.900
34	112.89	203202.	1.442	0.00	0.000
35	112.90	203220.	1.462	0.00	0.000
36	0.00	0.	0.000	0.00	0.000
37	0.00	0.	0.000	0.00	0.000
38	0.00	0.	0.000		
39	0.00	0.	0.000		
40	0.00	0.	0.000.		

CALC. BY: RFDunny DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: DWilson DATE 3/6/80

Table A-7.1. Crack Growth Data - SEN 95-1

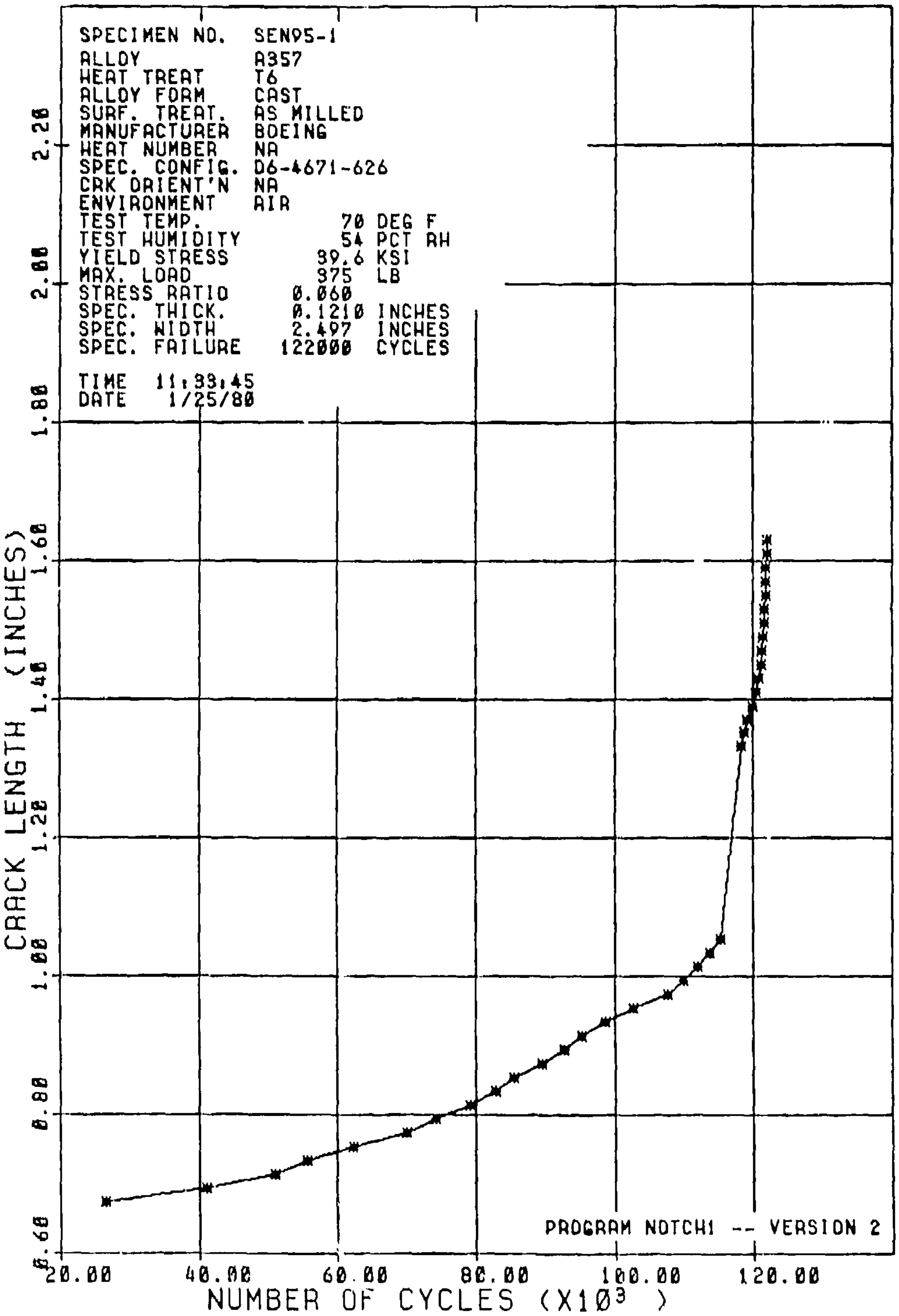

Table A-7.2. Crack Growth Data - SEN 95-1

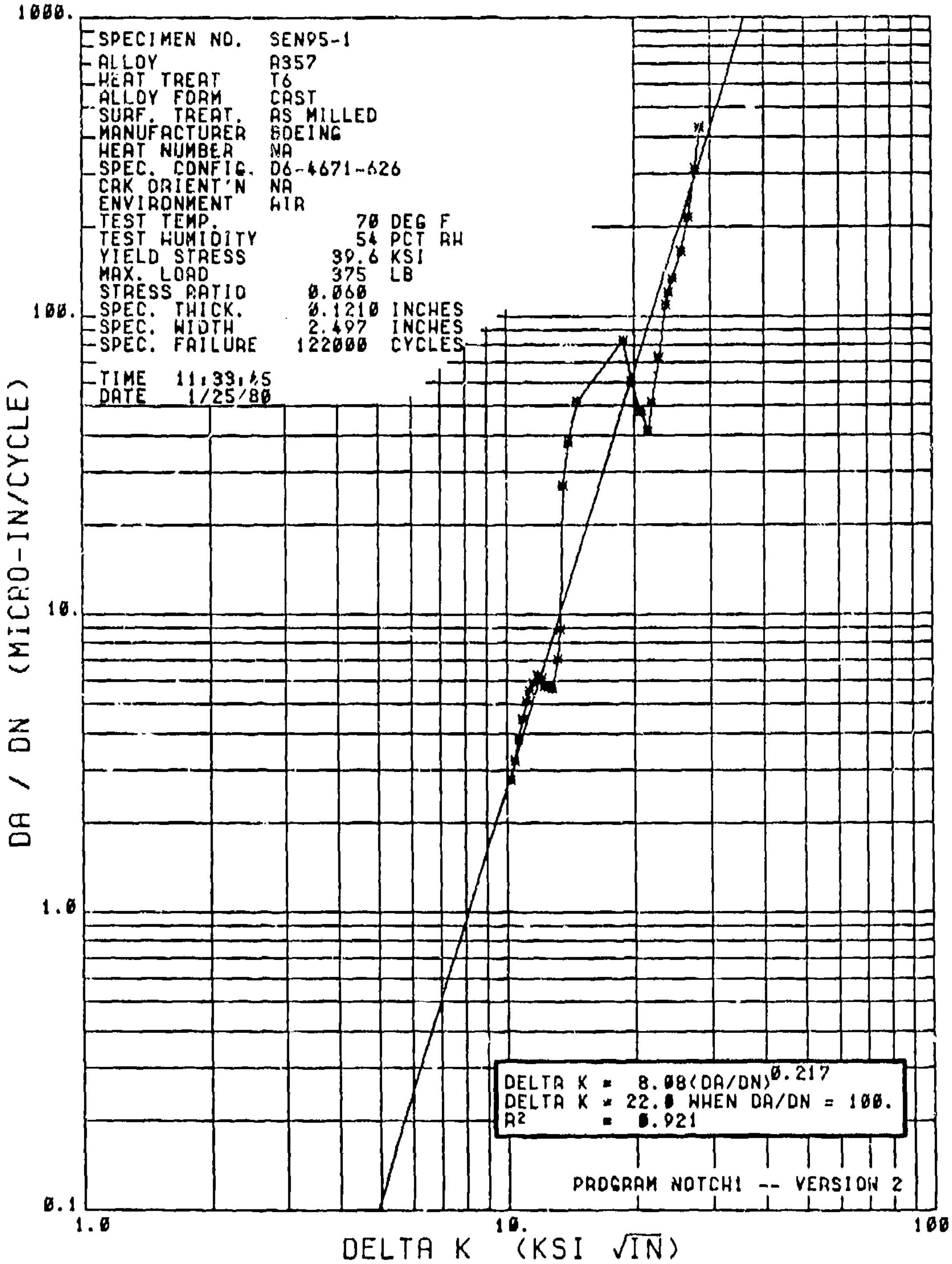

Table A-7.3. Crack Growth Data - SEN 95-1

SPECIMEN NO. SEN95-1

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	70	DEG F
TEST HUMIDITY	54	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.675	INCHES
A21	1.331	INCHES
B	0.1210	INCHES
W	2.497	INCHES
SPEC. FAILURE	122000	CYCLES

TIME 11:33:45
DATE 1/25/80

JOB NO. F1232E

COMPACT TENSION SPECIMEN

SEVEN POINT INCREMENTAL POLYNOMIAL METHOD FOR DETERMINING DA/DN.

PROGRAM NOTCH1 — VERSION NO. 2

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	14.81	26658.	0.675		
2	22.76	40968.	0.695		
3	28.18	50724.	0.715		
4	30.86	55548.	0.734	10.17	2.796
5	34.67	62406.	0.754	10.40	3.217
6	38.98	70164.	0.774	10.68	3.801
7	41.38	74484.	0.794	10.85	4.482
8	44.04	79272.	0.814	11.10	5.129
9	45.95	82710.	0.834	11.33	5.543
10	47.47	85446.	0.854	11.51	5.870
11	49.66	89388.	0.874	11.81	6.236
12	51.41	92538.	0.894	12.06	6.091
13	52.93	95274.	0.914	12.28	5.752
14	54.73	98514.	0.934	12.52	5.746
15	57.00	102600.	0.954	12.79	5.691
16	59.83	107694.	0.974	13.16	7.052
17	61.16	110088.	0.994	13.39	8.924
18	62.23	112014.	1.014	13.54	26.896
19	63.26	113868.	1.034	14.00	37.957
20	64.08	115344.	1.054	14.75	51.975
21	65.80	118440.	1.331	18.92	83.135
22	65.97	118746.	1.351	19.78	60.668
23	66.19	119142.	1.371	20.80	48.026
24	66.65	119970.	1.391	21.61	41.159
25	66.90	120420.	1.411	22.12	51.279
26	67.12	120816.	1.431	22.83	72.862
27	67.32	121176.	1.451	23.83	110.034
28	67.37	121266.	1.471	24.12	121.179
29	67.43	121374.	1.491	24.63	134.676
30	67.52	121536.	1.511	25.69	164.843
31	67.61	121698.	1.531	26.76	214.041
32	67.66	121788.	1.551	27.67	311.320
33	67.69	121842.	1.571	28.44	429.328
34	67.72	121896.	1.591	0.00	0.000
35	67.73	121914.	1.611	0.00	0.000
36	67.75	121950.	1.631	0.00	0.000
37	0.00	0.	0.000	0.00	0.000
38	0.00	0.	0.000		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

CALC. BY: [signature] DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D. [signature] DATE 7/6/80

Table A-8.1. Crack Growth Data - SEN 95-2

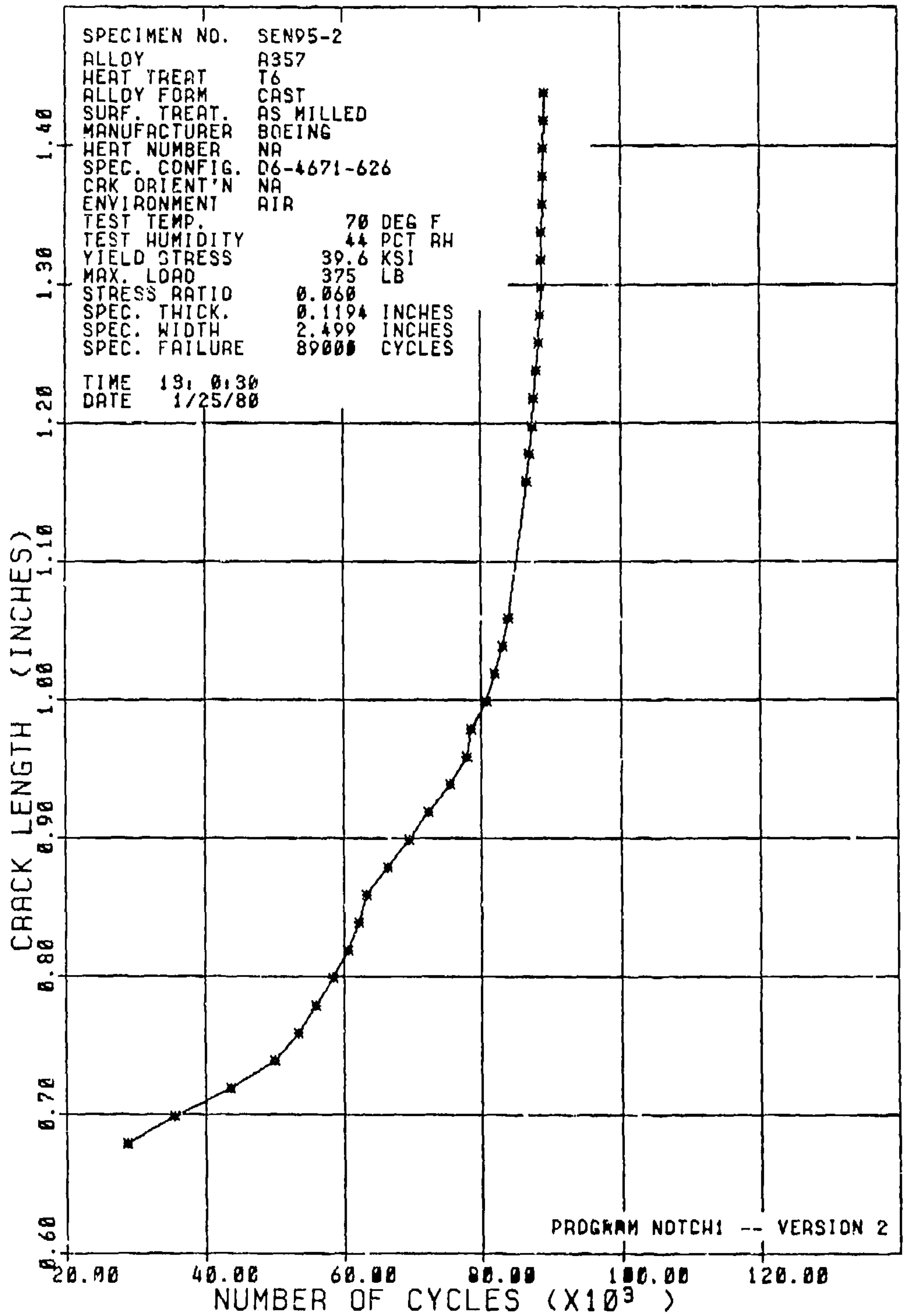

Table A-8.2. Crack Growth Data - SEN 95-2

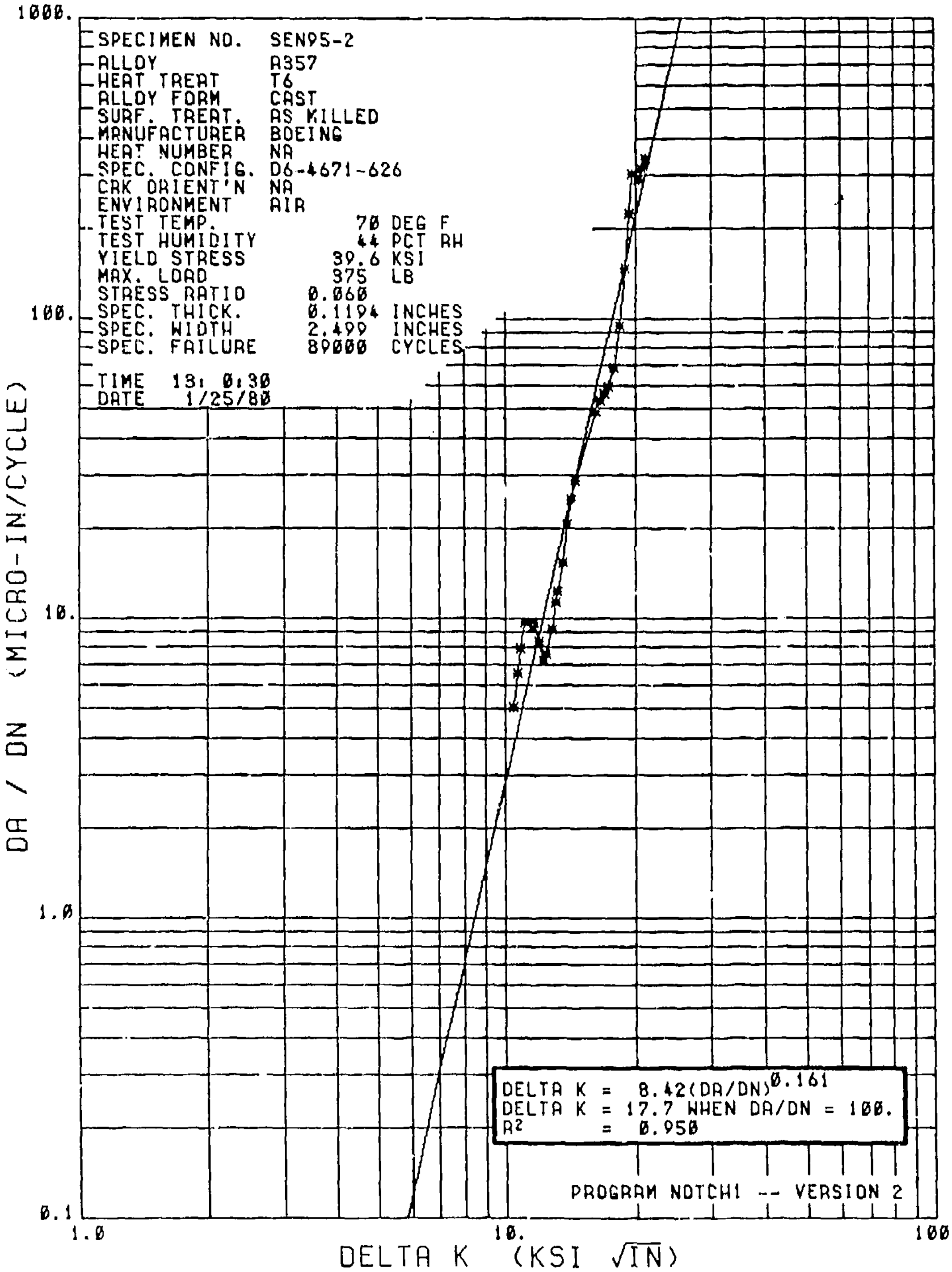

Table A-8.3. Crack Growth Data - SEN 95-2

SPECIMEN NO. SEN95-2

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	70	DEG F
TEST HUMIDITY	44	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.679	INCHES
A21	1.158	INCHES
B	0.1194	INCHES
W	2.499	INCHES
SPEC. FAILURE	89000	CYCLES

TIME 13: 0:30
DATE 1/25/80

JOB NO. F1232E

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***************************************
*                                     *
*  COMPACT TENSION SPECIMEN           *
*                                     *
*  SEVEN POINT INCREMENTAL POLYNOMIAL *
*  METHOD FOR DETERMINING DA/DN.      *
*                                     *
*  PROGRAM NOTCH1 -- VERSION NO. 2    *
*                                     *
***************************************
```

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	16.02	28836.	0.679		
2	19.83	35694.	0.699		
3	24.22	43596.	0.719		
4	27.83	50094.	0.739	10.45	5.079
5	29.72	53496.	0.759	10.63	6.549
6	31.08	55944.	0.779	10.80	7.956
7	32.47	58446.	0.799	11.04	9.727
8	33.72	60696.	0.819	11.32	9.725
9	34.59	62262.	0.839	11.52	9.381
10	35.27	63486.	0.859	11.67	9.674
11	36.94	66492.	0.879	11.99	8.401
12	38.63	69534.	0.899	12.25	7.245
13	40.17	72306.	0.919	12.47	7.609
14	42.03	75654.	0.939	12.81	9.225
15	43.32	77976.	0.959	13.10	11.348
16	43.72	78696.	0.979	13.20	12.304
17	44.89	80802.	0.999	13.61	15.413
18	45.57	82[illegible]6.	1.019	13.85	20.584
19	46.18	83124.	1.039	14.19	24.894
20	46.65	83970.	1.059	14.51	28.920
21	48.13	86634.	1.158	16.22	49.080
22	48.33	86994.	1.178	16.55	53.559
23	48.56	87408.	1.198	16.99	56.040
24	48.70	87660.	1.218	17.30	59.249
25	48.91	88038.	1.238	17.77	68.532
26	49.11	88398.	1.258	18.34	95.266
27	49.24	88632.	1.278	18.91	147.279
28	49.30	88740.	1.298	19.31	224.378
29	49.34	88812.	1.318	19.68	302.805
30	49.38	88884.	1.338	20.32	290.011
31	49.40	88920.	1.358	20.67	315.477
32	49.43	88974.	1.378	21.15	338.746
33	49.49	89082.	1.398	0.00	0.000
34	49.51	89118.	1.418	0.00	0.000
35	49.52	89136.	1.438	0.00	0.000
36	0.00	0.	0.000	0.00	0.000
37	0.00	0.	0.000	0.00	0.000
38	0.00	0.	0.000		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

CALC. BY: RFDunny DATE 1-24-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D. Wilson DATE 3/6/80

Table A-9.1. Crack Growth Data - SEN 25-1

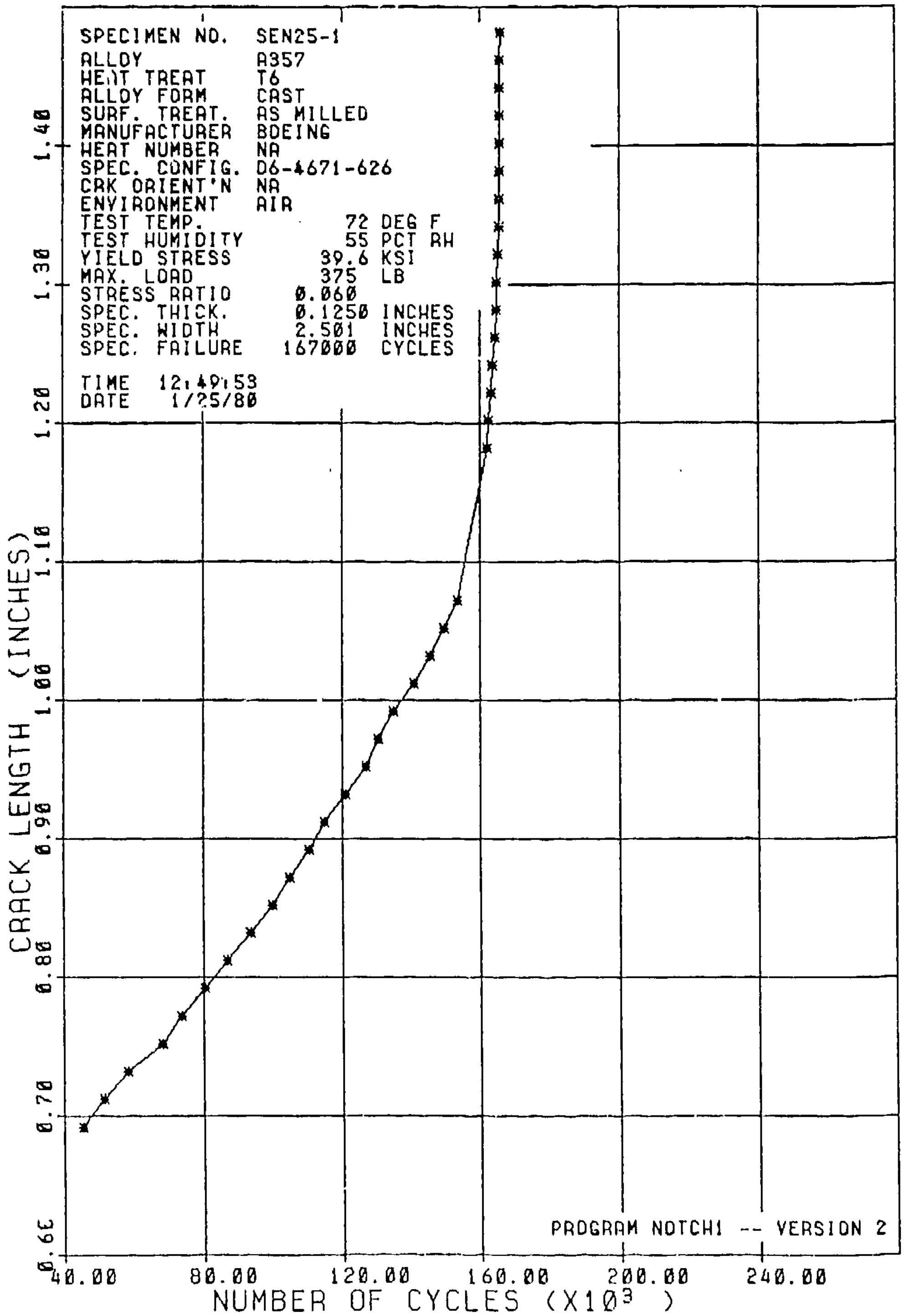

Table A-9.2. Crack Growth Data - SEN 25-1

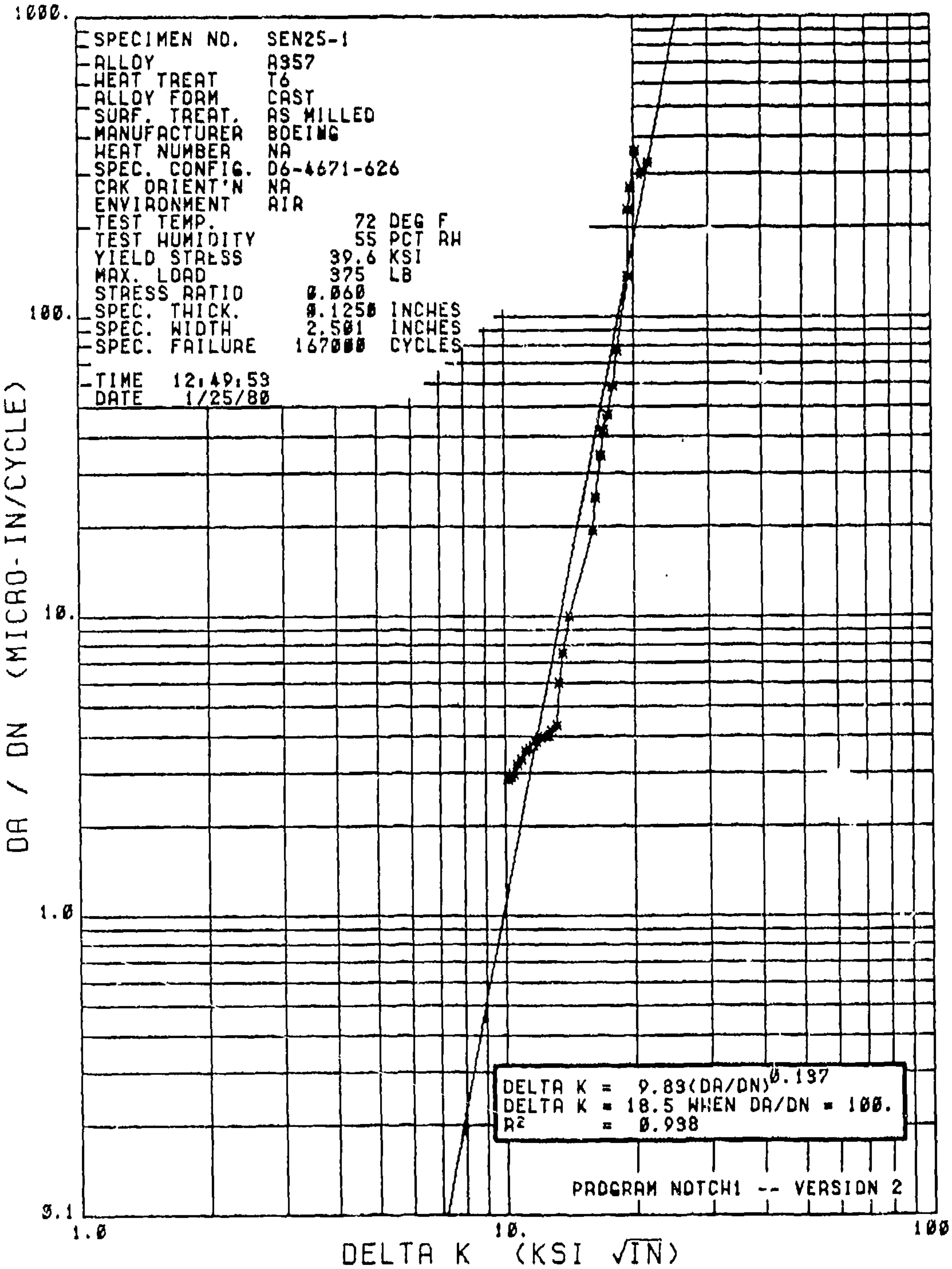

Table A-9.3. Crack Growth Data - SEN 25-1

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*************************************
*                                   *
*  COMPACT TENSION SPECIMEN         *
*                                   *
*  SEVEN POINT INCREMENTAL POLYNOMIAL *
*  METHOD FOR DETERMINING DA/DN.    *
*                                   *
*  PROGRAM NOTCH1  --  VERSION NO. 2 *
*                                   *
*************************************
```

SPECIMEN NO. SEN25-1

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	72	DEG F
TEST HUMIDITY	55	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.692	INCHES
A21	1.182	INCHES
B	0.1250	INCHES
W	2.501	INCHES
SPEC. FAILURE	167000	CYCLES

TIME 12:49:53
DATE 1/25/80

JOB NO. F1232E

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	25.27	45486.	0.692		
2	28.76	51768.	0.712		
3	32.38	58284.	0.732		
4	37.90	68220.	0.752	10.08	2.859
5	41.20	74160.	0.772	10.25	2.901
6	44.68	80424.	0.792	10.45	2.984
7	48.22	86796.	0.812	10.67	3.210
8	52.01	93618.	0.832	10.91	3.315
9	55.51	99918.	0.852	11.14	3.565
10	58.20	104760.	0.872	11.35	3.640
11	61.30	110340.	0.892	11.61	3.700
12	63.74	114732.	0.912	11.81	3.836
13	67.11	120798.	0.932	12.08	3.953
14	70.41	126738.	0.952	12.39	3.979
15	72.40	130320.	0.972	12.57	3.966
16	74.91	134838.	0.992	12.82	4.158
17	78.21	140778.	1.012	13.16	4.329
18	80.89	145602.	1.032	13.37	6.009
19	83.02	149436.	1.052	13.69	7.570
20	85.28	153504.	1.072	14.14	9.977
21	89.89	161802.	1.182	16.05	19.400
22	90.23	162414.	1.202	16.29	24.930
23	90.72	163296.	1.222	16.75	34.548
24	90.98	163764.	1.242	17.04	41.805
25	91.25	164250.	1.262	17.48	47.134
26	91.47	164646.	1.292	17.95	58.385
27	91.63	164934.	1.302	18.36	76.645
28	91.87	165366.	1.322	19.44	137.155
29	91.89	165402.	1.342	19.55	228.041
30	91.92	165456.	1.362	19.78	269.071
31	91.94	165492.	1.382	20.28	356.843
32	91.99	165582.	1.402	21.02	299.641
33	92.04	165672.	1.422	21.74	327.115
34	92.07	165726.	1.442	0.00	0.000
35	92.10	165780.	1.462	0.00	0.000
36	92.12	165816.	1.482	0.00	0.000
37	0.00	0.	0.000	0.00	0.000
38	0.00	0.	0.000		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

CALC. BY: Ray Dunny DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D Vlha DATE 3/4/80

Table A-10.1. Crack Growth Data - SEN 25-2

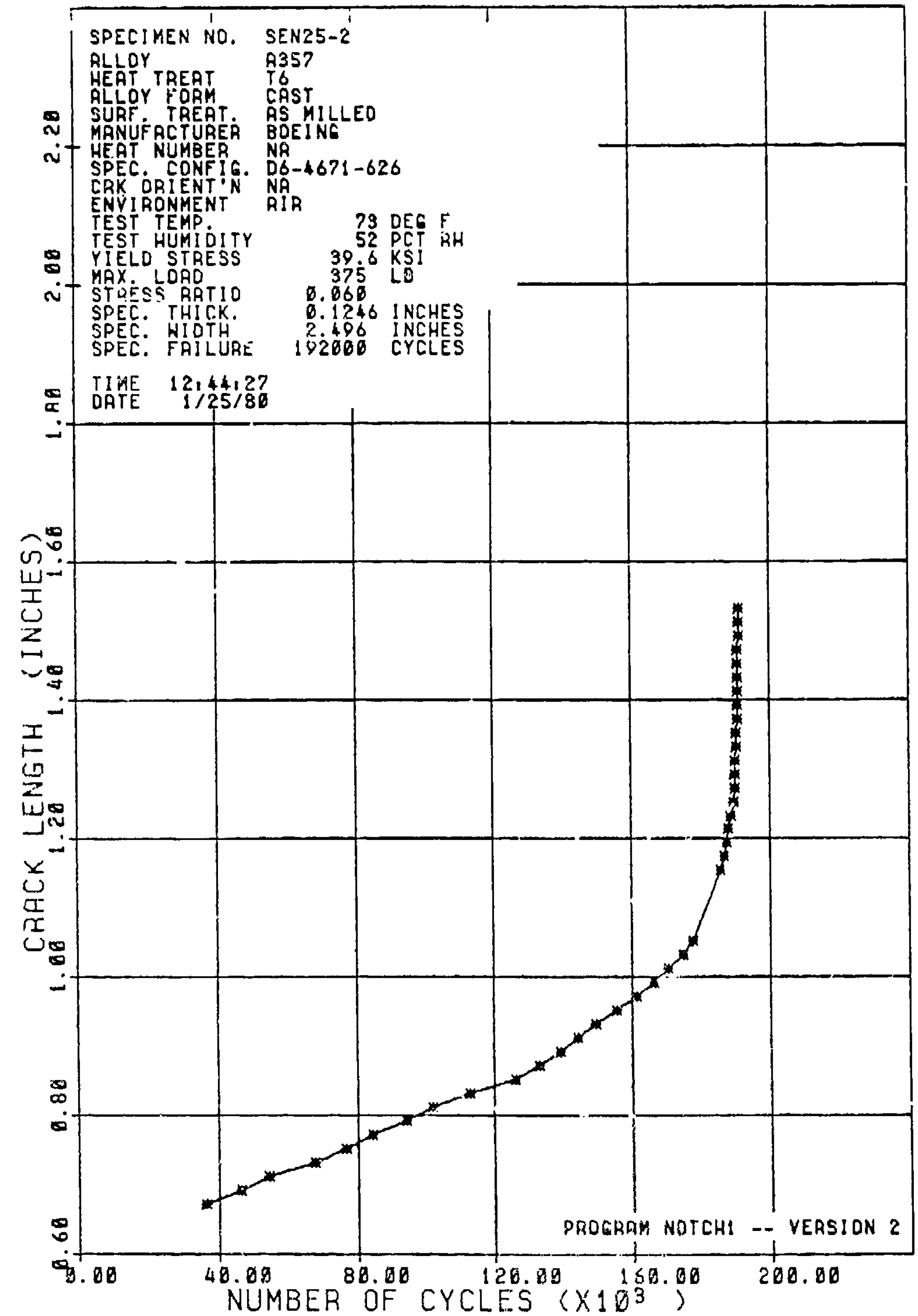

Table A-10.2. Crack Growth Data - SEN 25-2

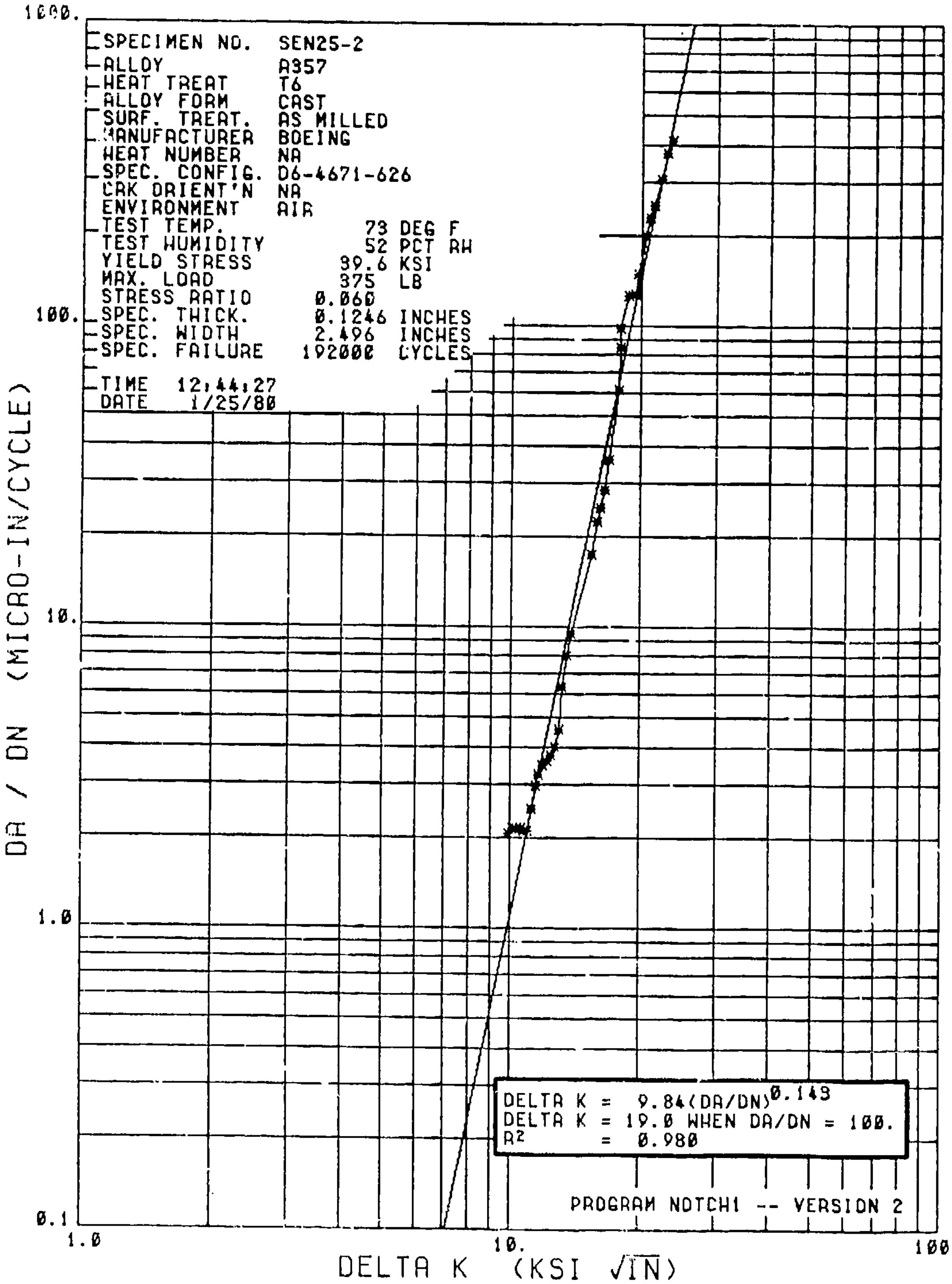

Table A-10.3. Crack Growth Data - SEN 25-2

SPECIMEN NO. SEN25-2

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	73	DEG F
TEST HUMIDITY	52	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1600.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/1IN
GRID SPACING	0.020	INCHES
A1	0.672	INCHES
A21	1.153	INCHES
B	0.1246	INCHES
W	2.496	INCHES
SPEC. FAILURE	192000	CYCLES

TIME 12:44:27
DATE 1/25/80

JOB NO. F1232E

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*****************************************
*                                       *
*  COMPACT TENSION SPECIMEN             *
*                                       *
*  SEVEN POINT INCREMENTAL POLYNOMIAL   *
*  METHOD FOR DETERMINING DA/DN.        *
*                                       *
*  PROGRAM NOTCH1  --  VERSION NO. 2    *
*                                       *
*****************************************
```

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	20.21	36378.	0.672		
2	25.76	46368.	0.692		
3	30.13	54234.	0.712		
4	37.50	67500.	0.732	9.92	2.053
5	42.73	76914.	0.752	10.11	2.148
6	46.97	84546.	0.772	10.29	2.132
7	52.49	94482.	0.792	10.55	2.139
8	56.65	101970.	0.812	10.72	2.106
9	62.71	112878.	0.832	10.95	2.099
10	69.89	125802.	0.852	11.24	2.486
11	74.04	133272.	0.872	11.45	2.964
12	77.27	139086.	0.892	11.66	3.237
13	80.13	144234.	0.912	11.89	3.465
14	83.19	149742.	0.932	12.15	3.604
15	86.49	155682.	0.952	12.42	3.739
16	89.58	161244.	0.972	12.68	3.975
17	92.48	166464.	0.992	12.96	4.540
18	94.72	170496.	1.012	13.17	6.324
19	97.08	174744.	1.032	13.55	8.043
20	98.58	177444.	1.052	13.84	9.520
21	103.05	185490.	1.153	15.51	17.483
22	103.74	186732.	1.173	15.92	22.468
23	104.18	187524.	1.193	16.25	24.910
24	104.49	188082.	1.213	16.52	28.522
25	104.84	188712.	1.233	16.95	35.724
26	105.39	189702.	1.253	17.88	61.355
27	105.45	189810.	1.273	17.99	84.251
28	105.48	189864.	1.293	18.02	97.453
29	105.60	190080.	1.313	18.73	125.795
30	105.75	190350.	1.333	19.45	126.562
31	105.80	190440.	1.353	19.70	148.225
32	105.92	190620.	1.373	20.49	198.791
33	105.95	190710.	1.393	21.02	228.776
34	105.98	190764.	1.413	21.37	250.813
35	106.03	190854.	1.433	22.18	306.076
36	106.07	190926.	1.453	22.92	373.603
37	106.10	190980.	1.473	23.63	410.874
38	106.12	191016.	1.493		
39	106.14	191052.	1.513		
40	106.17	191106.	1.533		

CALC. BY: [illegible] DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: [illegible] DATE 3/6/80

Table A-11.1. Crack Growth Data - SENH 93-1

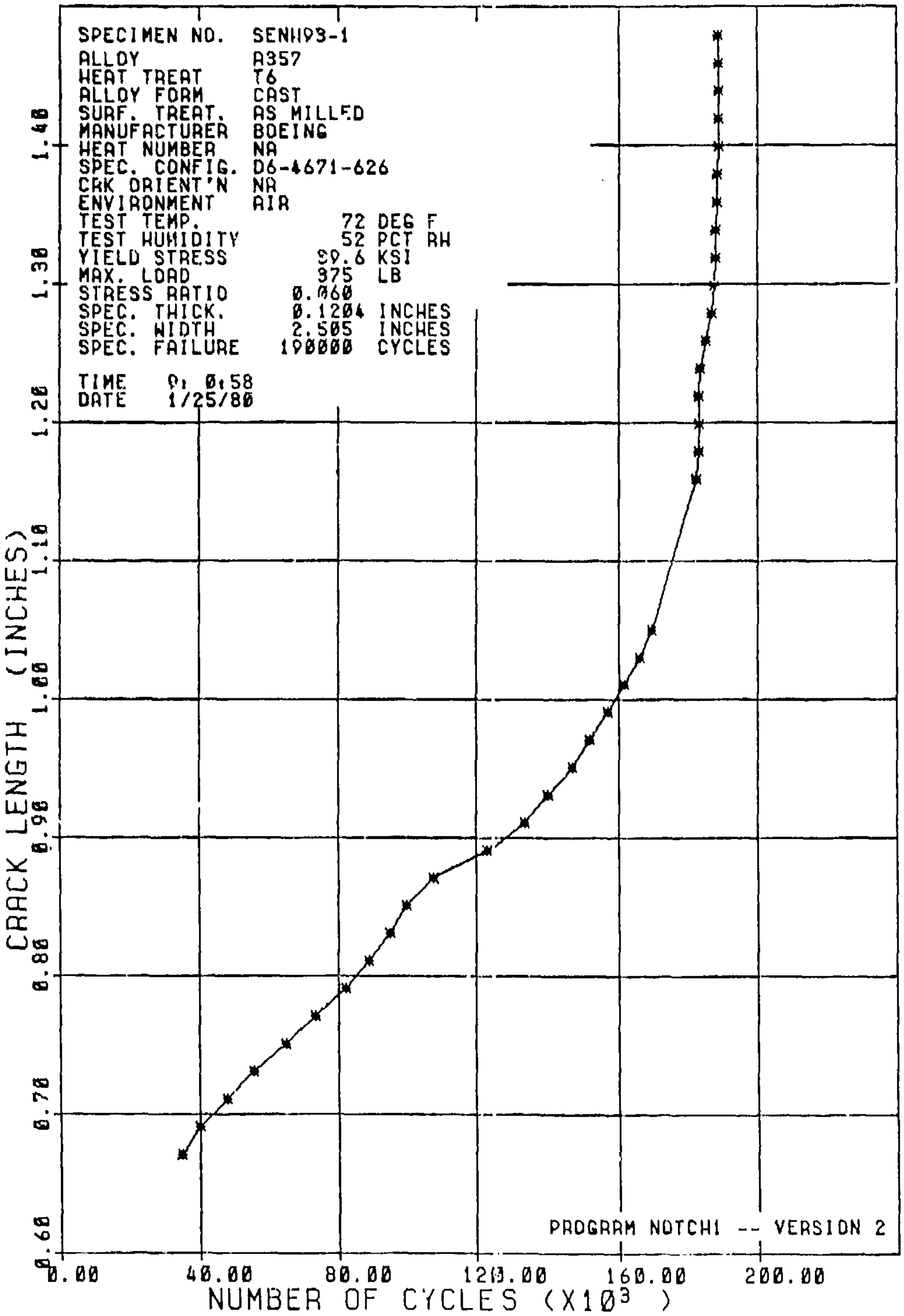

Table A-11.2. Crack Growth Data - SENH 93-1

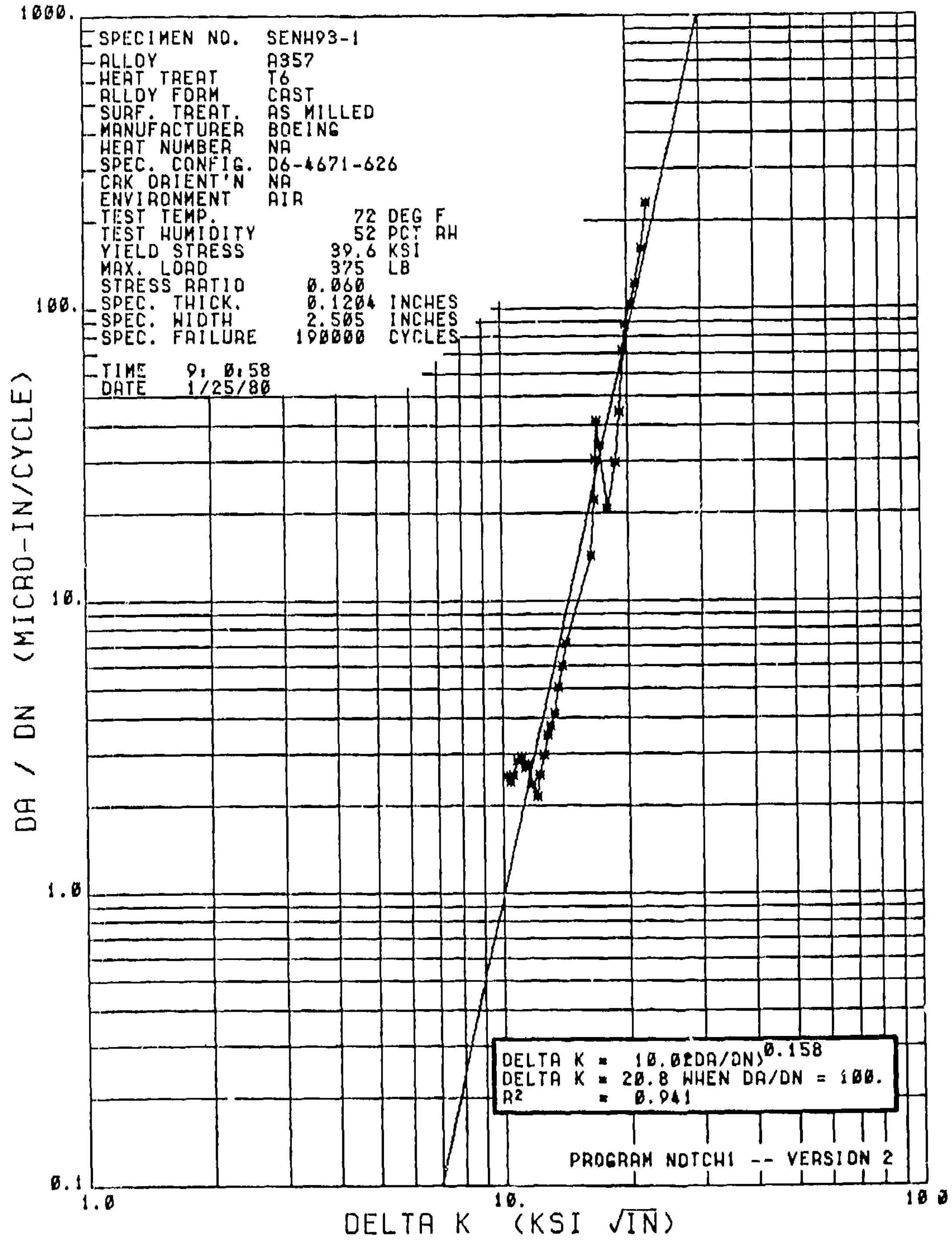

Table A-11.3. Crack Growth Data - SENH 93-1

SPECIMEN NO. SENH93-1

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	72	DEG F
TEST HUMIDITY	52	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.671	INCHES
A21	1.159	INCHES
B	0.1204	INCHES
W	2.505	INCHES
SPEC. FAILURE	190000	CYCLES

TIME 9: 0:58
DATE 1/25/80

JOB NO. E1232E

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*****************************************
*                                       *
*  COMPACT TENSION SPECIMEN             *
*                                       *
*  SEVEN POINT INCREMENTAL POLYNOMIAL   *
*  METHOD FOR DETERMINING DA/DN.        *
*                                       *
*  PROGRAM NOTCH1  —  VERSION NO. 2     *
*                                       *
*****************************************
```

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	19.25	34650.	0.671		
2	22.23	40014.	0.691		
3	26.56	47808.	0.711		
4	30.88	55584.	0.730	10.17	2.523
5	35.98	64764.	0.750	10.39	2.411
6	40.67	73206.	0.770	10.60	2.528
7	45.58	82044.	0.790	10.84	2.858
8	49.25	88650.	0.810	11.07	2.946
9	52.56	94608.	0.830	11.31	2.708
10	55.32	99576.	0.850	11.47	2.771
11	59.79	107622.	0.870	11.68	2.359
12	68.53	123354.	0.890	12.04	2.137
13	73.99	133182.	0.910	12.28	2.551
14	77.58	139644.	0.930	12.48	2.979
15	81.46	146628.	0.950	12.78	3.466
16	84.14	151452.	0.970	13.02	3.749
17	87.11	156798.	0.990	13.30	4.125
18	89.67	161406.	1.010	13.54	5.046
19	92.30	166140.	1.030	13.89	6.003
20	94.31	169758.	1.050	14.21	7.121
21	101.23	182214.	1.159	16.37	14.325
22	101.67	183006.	1.179	16.73	22.038
23	101.81	183258.	1.199	16.80	30.227
24	101.83	183294.	1.219	16.93	41.161
25	102.08	183744.	1.239	17.23	34.171
26	102.97	185346.	1.259	17.97	20.663
27	103.85	186930.	1.279	18.71	29.774
28	104.15	187470.	1.299	19.14	44.284
29	104.37	187866	1.319	19.60	71.730
30	104.49	188082.	1.339	19.9[illegible]	87.895
31	104.61	188298.	1.359	20.5[illegible]	104.105
32	104.70	188460.	1.379	21.01	122.186
33	104.81	188658.	1.399	21.76	160.947
34	104.88	188784.	1.419	22.42	228.820
35	104.93	188874.	1.439	0.00	0.000
36	104.96	188928.	1.459	0.00	0.000
37	104.98	188964.	1.479	0.00	0.000
38	0.00	0.	0.000		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

CALC. BY: R F Dunn DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D Nelson DATE 7/6/80

Table A-12.1. Crack Growth Data - SENH 93-2

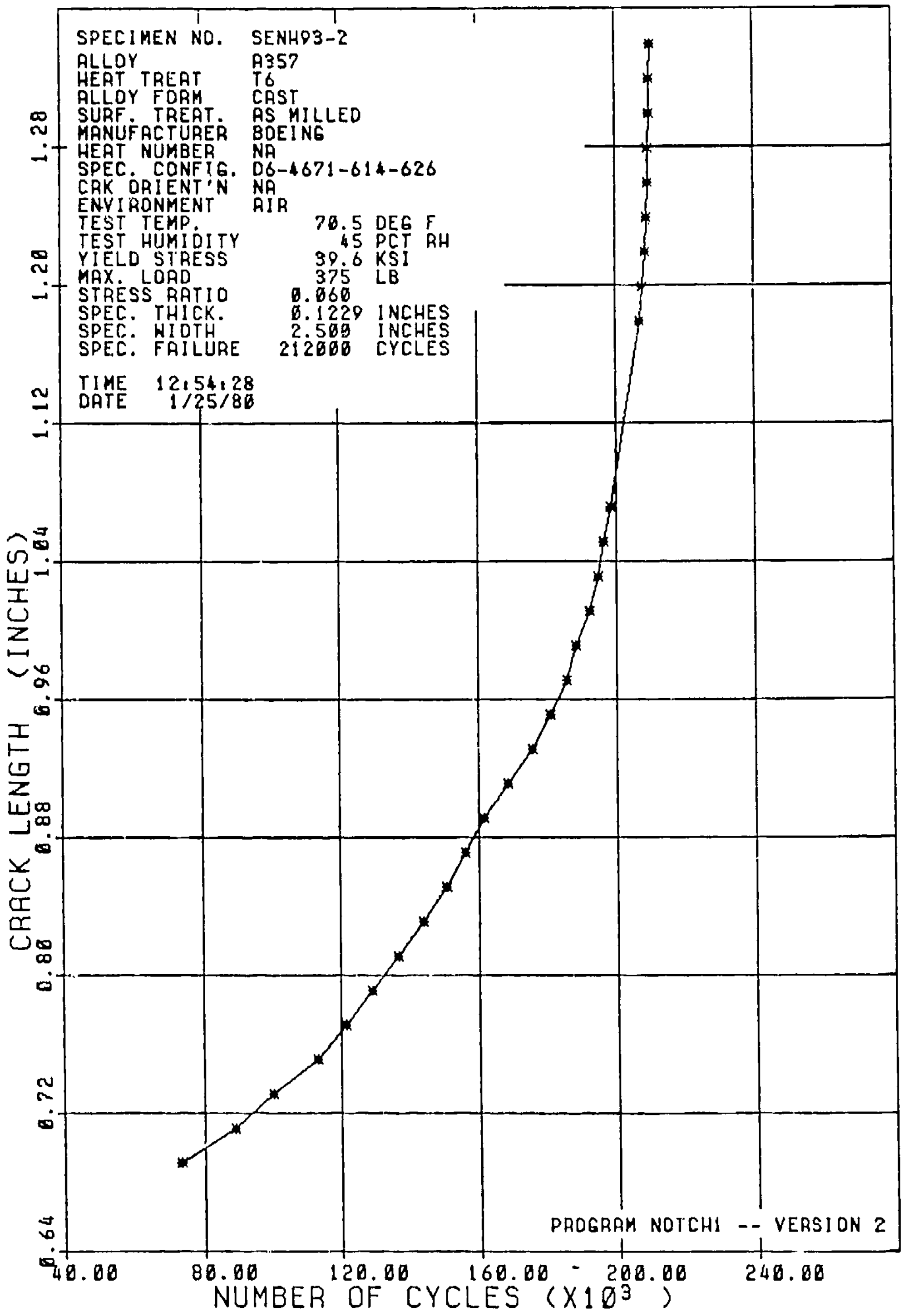

Table A-12.2. Crack Growth Data - SENH 93-2

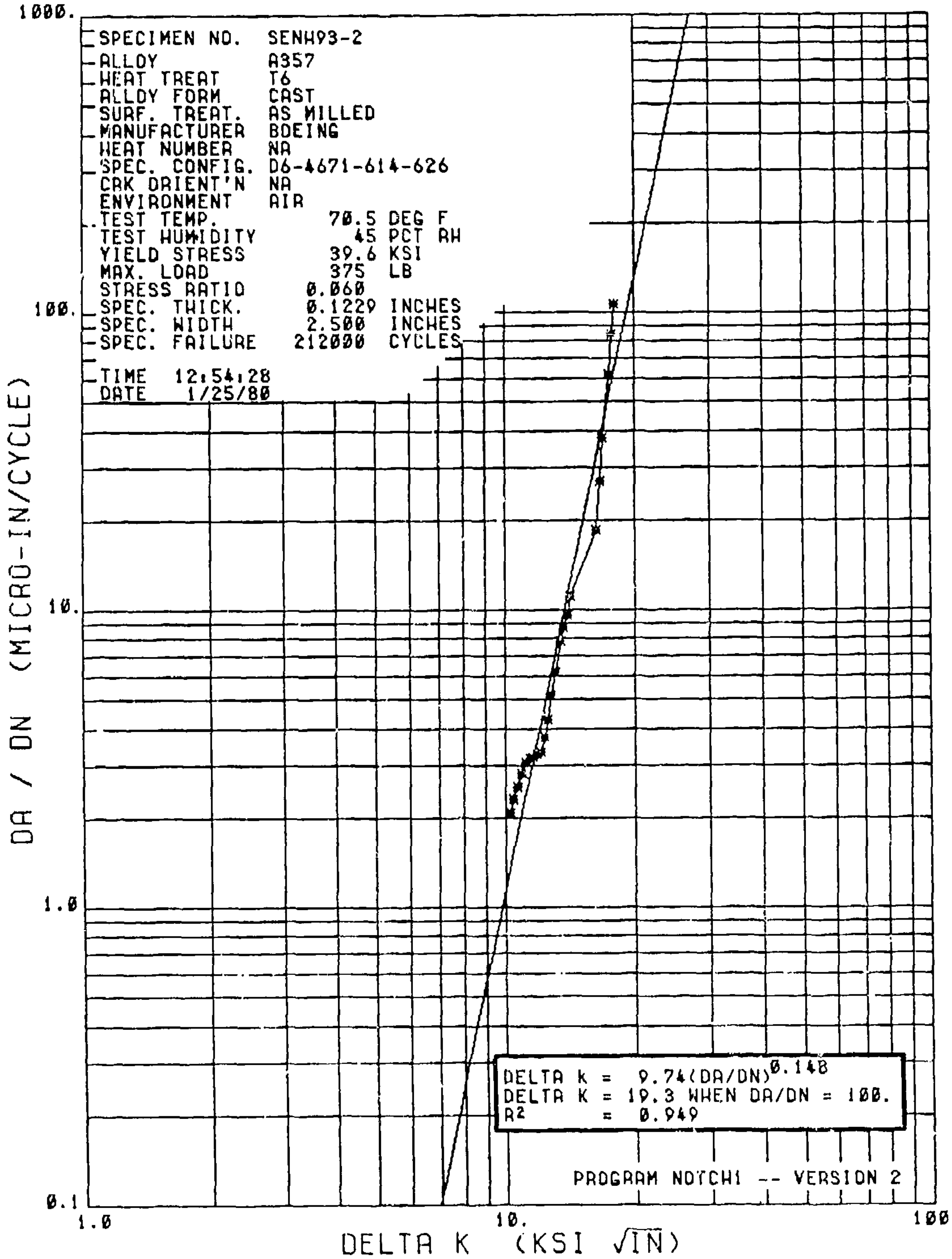

Table A-12.3. Crack Growth Data - SENH 93-2

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**************************************
*                                    *
*  COMPACT TENSION SPECIMEN          *
*                                    *
*  SEVEN POINT INCREMENTAL POLYNOMIAL *
*  METHOD FOR DETERMINING DA/DN.     *
*                                    *
*  PROGRAM NOTCH1  --  VERSION NO. 2 *
*                                    *
**************************************
```

SPECIMEN NO. SENH93-2

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SUF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-614-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	70.5	DEG F
TEST HUMIDITY	45	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.692	INCHES
A21	1.180	INCHES
B	0.1229	INCHES
W	2.500	INCHES
SPEC. FAILURE	212000	CYCLES

TIME 12:54:28
DATE 1/25/80

JOB NO. F1263E

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	40.57	73026.	0.692		
2	49.29	88722.	0.711		
3	55.50	99900.	0.731		
4	62.95	113310.	0.751	10.24	2.080
5	67.50	121500.	0.771	10.43	2.318
6	71.86	129348.	0.791	10.63	2.537
7	76.07	136926.	0.811	10.87	2.830
8	80.00	144000.	0.831	11.09	3.058
9	83.75	150750.	0.851	11.34	3.179
10	86.64	155952.	0.871	11.55	3.189
11	89.80	161640.	0.891	11.77	3.264
12	93.53	168354.	0.911	12.04	3.343
13	97.49	175482.	0.931	12.32	3.744
14	100.34	180612.	0.951	12.56	4.273
15	103.00	185400.	0.971	12.84	5.195
16	104.66	188388.	0.991	13.05	6.150
17	106.95	192510.	1.011	13.43	7.888
18	108.12	194616.	1.031	13.68	8.717
19	109.18	196524.	1.051	13.93	9.584
20	110.21	198378.	1.071	14.23	11.100
21	115.12	207216.	1.180	16.28	18.461
22	115.64	208152.	1.200	16.63	26.993
23	115.94	208692.	1.219	16.97	37.918
24	116.31	209358.	1.239	17.51	62.076
25	116.45	209610.	1.259	17.83	84.641
26	116.54	209772.	1.279	18.11	106.546
27	116.65	209970.	1.299	0.00	0.000
28	116.75	210150.	1.319	0.00	0.000
29	116.80	210240.	1.339	0.00	0.000
30	0.00	0.	0.000	0.00	0.000
31	0.00	0.	0.000	0.00	0.000
32	0.00	0.	0.000	0.00	0.000
33	0.00	0.	0.000	0.00	0.000
34	0.00	0.	0.000	0.00	0.000
35	0.00	0.	0.000	0.00	0.000
36	0.00	0.	0.000	0.00	0.000
37	0.00	0.	0.000	0.00	0.000
38	0.00	0.	0.000		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

CALC. BY: R F Dury DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D. Huber DATE 3/6/80

Table A-13.1. Crack Growth Data - SENH 95-1

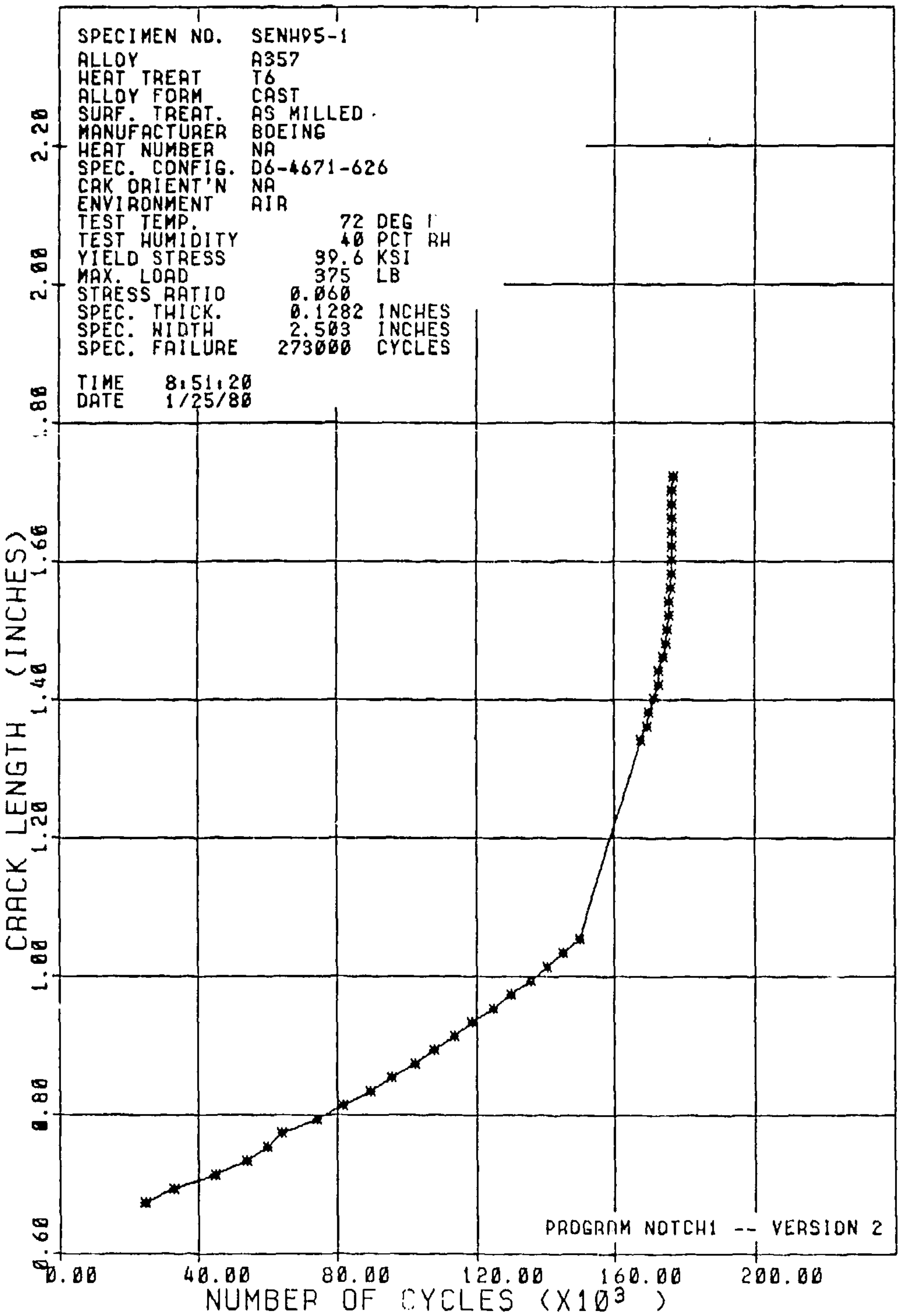

Table A-13.2. Crack Growth Data - SENH 95-1

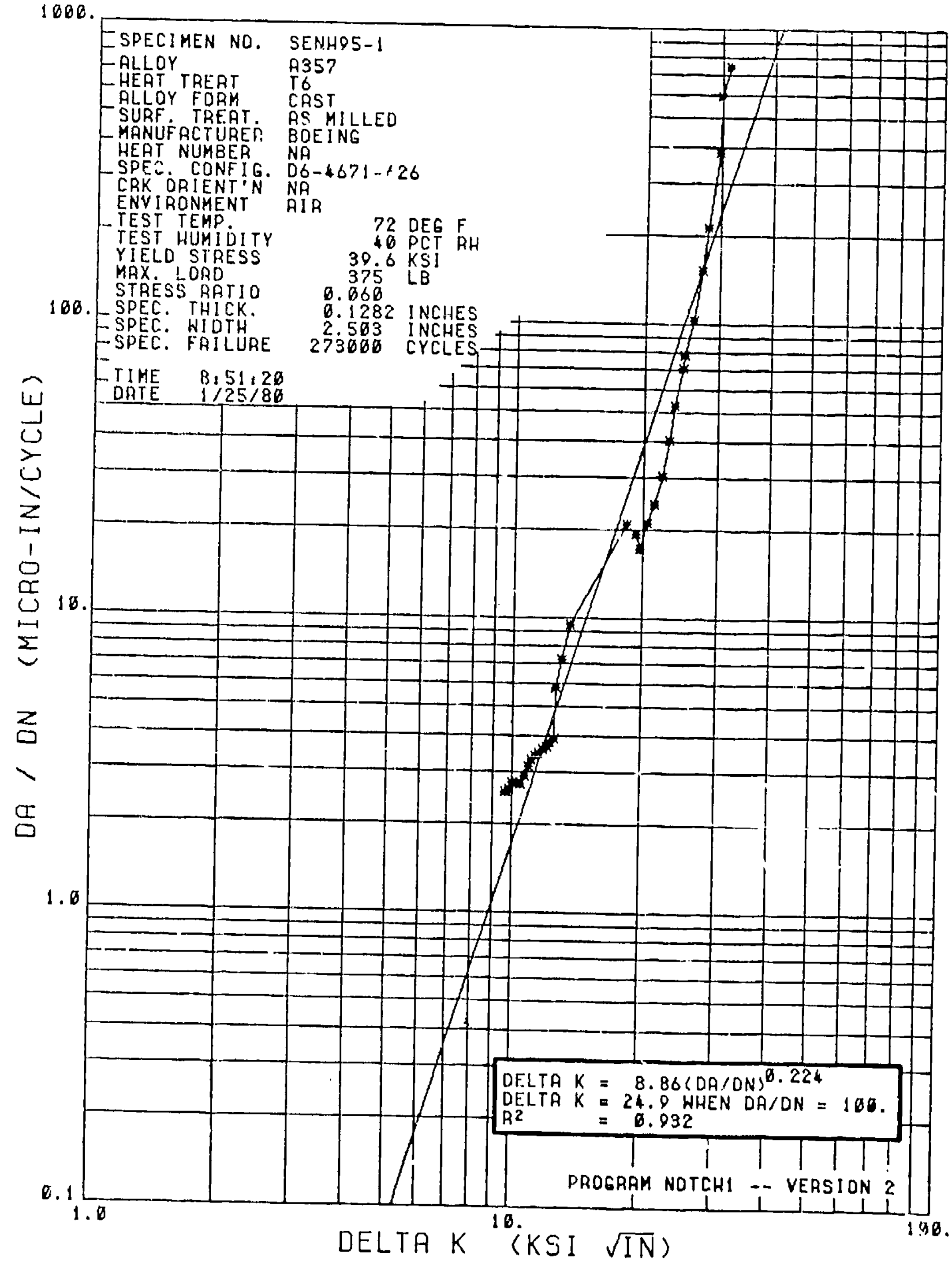

Table A-13.3. Crack Growth Data - SENH 95-1

SPECIMEN NO. SENH95-1

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	72	DEG F
TEST HUMIDITY	40	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1800.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.674	INCHES
A2	1.342	INCHES
B	0.1282	INCHES
W	2.503	INCHES
SPEC. FAILURE	273000	CYCLES

TIME 8:51:20
DATE 1/25/80

JOB NO. F1232E

COMPACT TENSION SPECIMEN

SEVEN POINT INCREMENTAL POLYNOMIAL METHOD FOR DETERMINING DA/DN.

PROGRAM NOTCH1 — VERSION NO. 2

GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	13.83	24894.	0.674		
2	18.38	33084.	0.693		
3	24.84	44712.	0.713		
4	29.93	53874.	0.733	9.64	2.558
5	33.43	60174.	0.753	9.80	2.627
6	35.55	63990.	0.773	9.93	2.760
7	41.42	74556.	0.793	10.23	2.763
8	45.23	81414.	0.813	10.41	2.730
9	49.75	89550.	0.833	10.64	2.902
10	53.09	95562.	0.853	10.84	3.119
11	56.83	102294.	0.873	11.05	3.302
12	59.80	107640.	0.893	11.30	3.416
13	63.01	113418.	0.913	11.54	3.491
14	66.09	118962.	0.933	11.78	3.586
15	69.41	124938.	0.953	12.04	3.638
16	72.33	130194.	0.973	12.28	3.798
17	75.26	135468.	0.993	12.55	3.903
18	77.95	140310.	1.013	12.64	5.777
19	80.62	145116.	1.033	13.03	7.221
20	83.44	150192.	1.053	13.56	9.459
21	93.05	167490.	1.342	18.39	20.802
22	94.14	169452.	1.362	19.41	19.349
23	94.37	169866.	1.382	19.77	17.255
24	95.38	171684.	1.402	20.58	20.977
25	96.00	172800.	1.422	21.32	24.436
26	96.02	172836.	1.442	21.31	24.371
27	96.63	173934.	1.462	22.31	30.463
28	97.04	174672.	1.482	23.06	40.250
29	97.32	175176.	1.502	23.85	52.621
30	97.58	175644.	1.522	24.86	71.158
31	97.61	175698.	1.542	24.96	78.477
32	97.79	176022.	1.562	26.14	103.375
33	97.92	176256.	1.582	27.30	151.874
34	97.98	176364.	1.602	28.18	213.459
35	98.05	176490.	1.622	29.94	381.589
36	98.06	176508.	1.642	30.19	594.771
37	98.08	176544.	1.662	31.34	745.690
38	98.09	176562.	1.682		
39	98.10	176580.	1.702		
40	98.12	176616.	1.722		

CALC. BY: R E Dunn DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APRD. BY: D Nuhn DATE 3/6/80

Table A-14.1. Crack Growth Data - SENH 95-2

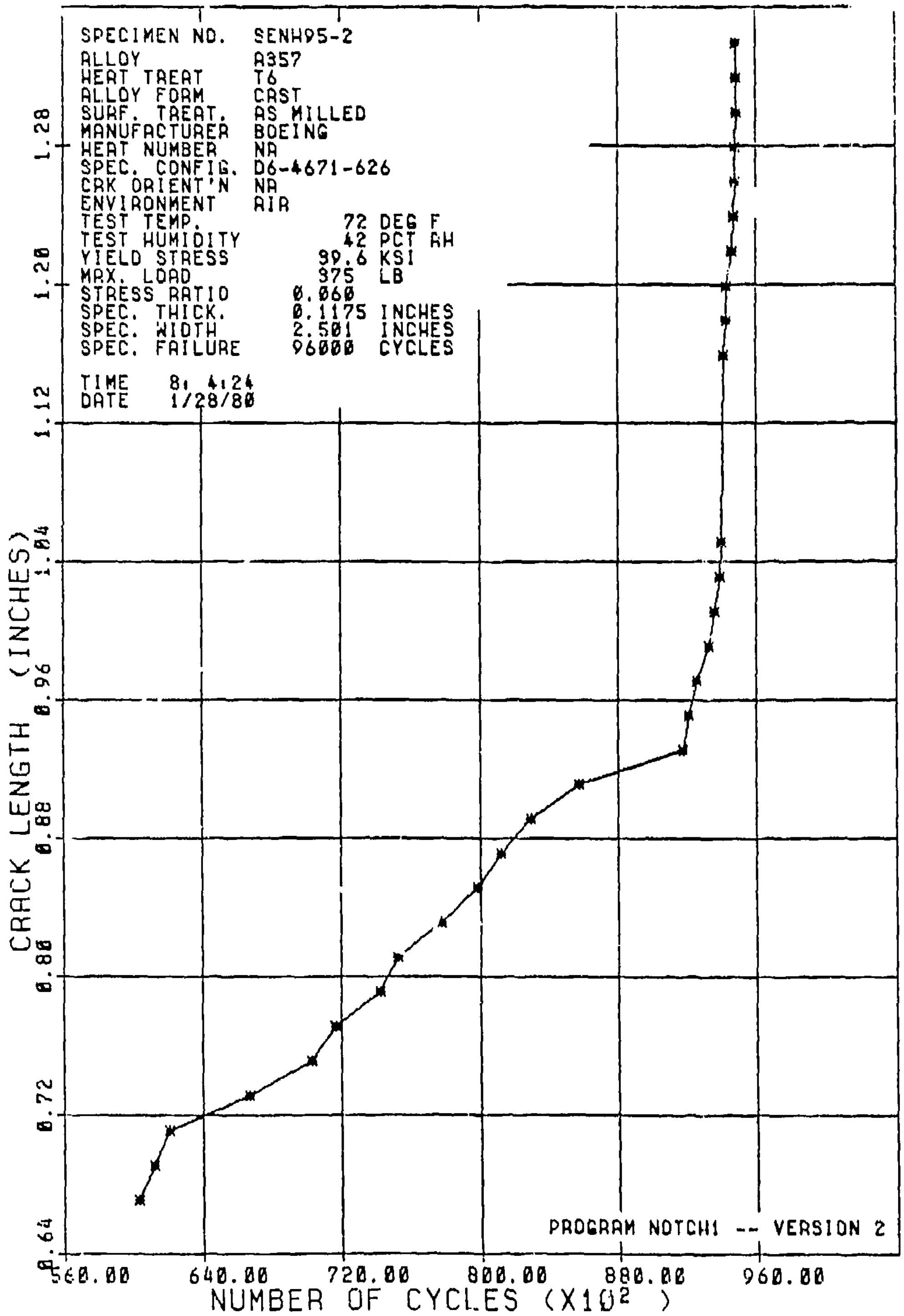

Table A-14.2. Crack Growth Data - SENH 95-2

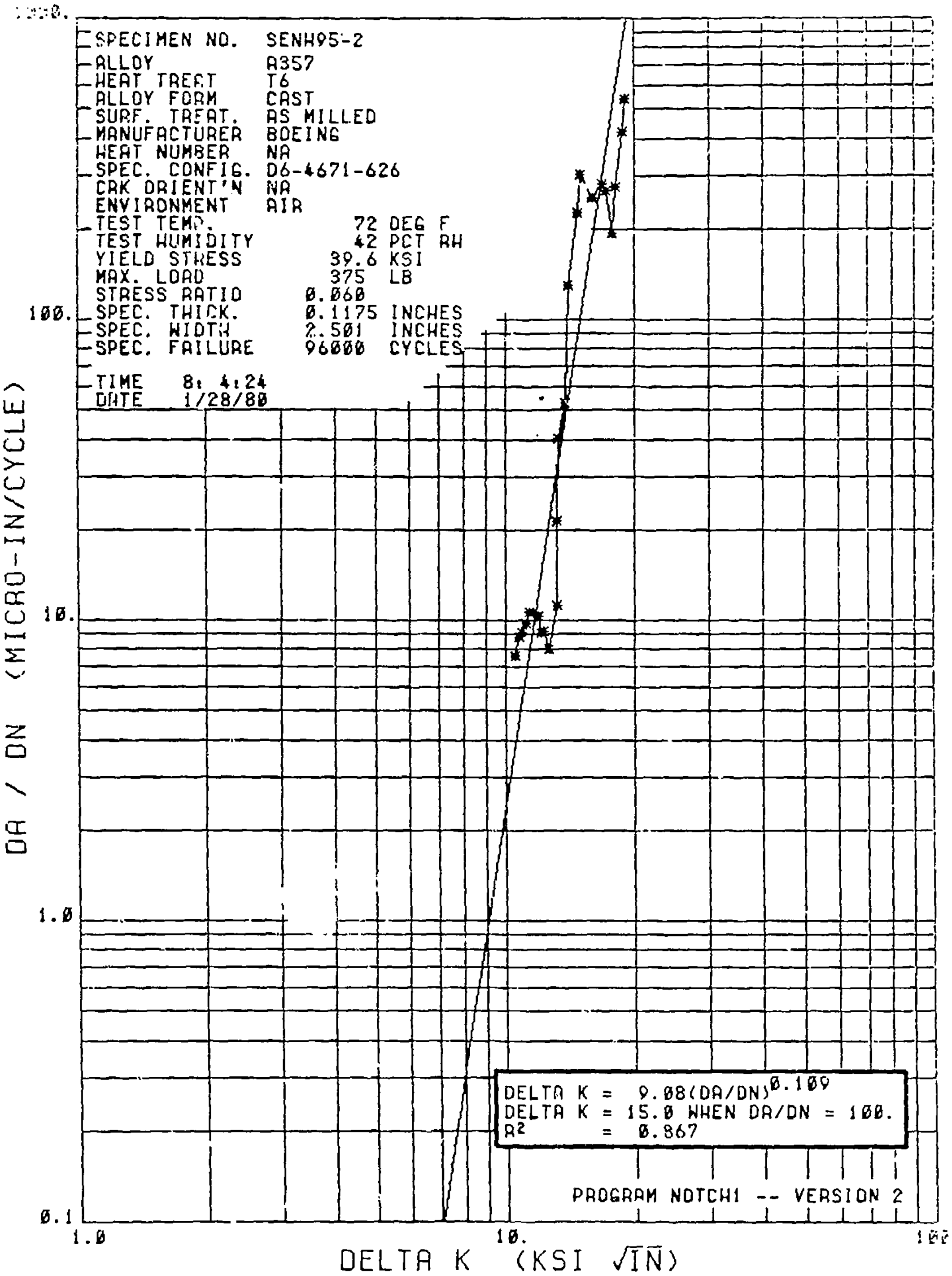

Table A-14.3. Crack Growth Data - SENH 95-2

SPECIMEN NO. SENH95-2

ALLOY	A357	
HEAT TREAT	T6	
ALLOY FORM	CAST	
SURF. TREAT.	AS MILLED	
MANUFACTURER	BOEING	
HEAT NUMBER	NA	
SPEC. CONFIG.	D6-4671-626	
CRK ORIENT'N	NA	
ENVIRONMENT	AIR	
TEST TEMP.	72	DEG F
TEST HUMIDITY	42	PCT RH
YIELD STRESS	39.6	KSI
MAX. LOAD	375.	LB
CYCLIC RATE	1300.	CPM
STRESS RATIO	0.060	
CHART SPEED	1.00	IN/MIN
GRID SPACING	0.020	INCHES
A1	0.071	INCHES
A21	1.159	INCHES
B	0.1175	INCHES
W	2.501	INCHES
SPEC. FAILURE	96000	CYCLES

TIME 8:4:24
DATE 1/28/80

JOB NO. F1232E

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***********************************
*                                 *
*  COMPACT TENSION SPECIMEN       *
*                                 *
*  SEVEN POINT INCREMENTAL POLYNOMIAL *
*  METHOD FOR DETERMINING DA/DN.  *
*                                 *
*  PROGRAM NOTCH1  --  VERSION NO. 2 *
*                                 *
***********************************
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GRID LINE NO.	CHART LENGTH (IN)	CYCLES	CRACK LENGTH (IN)	AVG. DELTA K (KSI-IN**.5)	AVG. DA/DN (MICRO-IN/CYCLE)
1	33.51	60318.	0.671		
2	33.98	61164.	0.691		
3	34.50	62100.	0.711		
4	37.05	66690.	0.731	10.46	7.591
5	39.06	70308.	0.751	10.73	8.832
6	39.83	71694.	0.771	10.86	9.115
7	41.26	74268.	0.791	11.16	9.826
8	41.76	75168.	0.811	11.29	10.658
9	43.15	77670.	0.831	11.58	10.655
10	44.36	79848.	0.851	11.88	10.330
11	45.10	81180.	0.871	12.07	9.085
12	46.11	82998.	0.891	12.29	9.185
13	47.63	85734.	0.911	12.57	8.013
14	50.99	91782.	0.931	13.17	11.191
15	51.16	92088.	0.951	13.23	21.436
16	51.40	92520.	0.971	13.29	40.176
17	51.80	93240.	0.991	13.75	52.576
18	52.00	93600.	1.011	14.03	129.242
19	52.17	93906.	1.031	14.73	226.104
20	52.23	94014.	1.051	14.92	304.718
21	52.33	94194.	1.159	15.96	253.946
22	52.38	94284.	1.179	16.78	282.192
23	52.42	94356.	1.199	17.17	268.320
24	52.56	94608.	1.219	17.83	193.282
25	52.60	94680.	1.239	18.06	275.034
26	52.65	94770.	1.259	18.71	419.613
27	52.67	94806.	1.279	19.03	539.874
28	52.69	94842.	1.299	0.00	0.000
29	52.70	94860.	1.319	0.00	0.000
30	52.72	94896.	1.339	0.00	0.000
31	0.00	0.	0.000	0.00	0.000
32	0.00	0.	0.000	0.00	0.000
33	0.00	0.	0.000	0.00	0.000
34	0.00	0.	0.000	0.00	0.000
35	0.00	0.	0.000	0.00	0.000
36	0.00	0.	0.000	0.00	0.000
37	0.00	0.	0.000	0.00	0.000
38	0.00	0.	0.000		
39	0.00	0.	0.000		
40	0.00	0.	0.000		

CALC. BY: R.E. Denny DATE 1-25-80

CHKD. BY: W. WRIGHT DATE 11-20-79

APPD. BY: D. Nelson DATE 3/6/80

APPENDIX B

FRACTURE TOUGHNESS TEST DATA

Table B-1. Fracture Toughness Test Data

Specimen ID	C8L1	C8L2	C8L7	C8L8	C9L1	C9L2	C9L7	C9L8	CH2L1	CH2L2	CH2L7	CH2L8	CH9L1	CH9L2	CH9L7	CH9L8
a [in]	1.307	1.146	1.099	1.107	Failedd uring precracking	1.057	1.114	Failed during precraking	1.038	1.057	1.162	1.117	1.059	1.168	.985	Failed during precracking
B [in]	1.188	.999	.983	1.000		.937	.991		.972	1.000	1.179	1.096	.979	.999	1.194	
W [in]	2.004	2.005	2.006	2.002		2.001	2.003		2.002	2.002	2.003	2.004	2.005	2.003	2.005	
P_F [lb]	2,200	1,300	1,300	1,300		1,200	1,300		1,300	1,500	1,300	2,000	1,500	1,200	1,200	
P_{max} [lb]	2,440	2,400	2,590	2,540		2,790	2,700		3,020	2,880	2,740	2,860	2,450	2,160	2,640	
P_Q [lb]	2,420	2,390	2,560	2,480		2,710	2,630		2,920	2,810	2,620	2,770	2,420	2,080	2,520	
K_Q [$ksi/\sqrt{in}$]	24.4	20.5	20.6	20.0		21.4	21.6		21.6	20.8	19.7	20.6	18.3	18.7	13.9	
a_1 [in]	1.262	1.142	1.092	1.115		1.076	1.091		1.010	1.050	1.145	1.104	1.026	1.132	.969	
a_2 [in]	1.348	1.162	1.135	1.132		1.076	1.135		1.061	1.084	1.188	1.152	1.084	1.195	1.017	
a_3 [in]	[illegible]	1.133	1.071	1.074		1.020	1.117		1.043	1.036	1.154	1.095	1.068	1.176	.968	
a_4 [in]	1.160	.985	.979	1.006		.995	.938		.908	.919	.955	.960	.880	.997	.868	
a_5 [in]	1.029	1.029	.938	.933		.926	.964		.965	.922	.968	.965	.976	1.019	.855	
$\lvert a_1 - a_2\rvert/a$	.065	.017	.039	.015		.000	.039		.049	.032	.037	.043	.055	.054	.049	
$\lvert a_2 - a_3\rvert/a$	.028	.025	.058	.052		.053	.016		.017	.045	.029	.051	.015	.016	.050	
$\lvert a_1 - a_3\rvert/a$	.038	.007	.019	.037		.053	023		.032	.013	.007	.008	.040	.038	.001	
a_4/a	.887	.860	.890	.909		.941	.841		.875	.870	.821	.859	.831	.854	.881	
a_5/a	.787	.898	.854	.843		.875	.865		.930	.872	.833	.864	.921	.873	.868	
P_{max}/P_Q	1.008	1.004	1.012	1.024		1.030	1.027		1.034	1.025	1.046	1.032	1.012	1.038	1.048	
K_F/K_Q	.909	.544	.508	.524		.443	.494		.445	.534	.496	.722	.620	.577	.476	
$2.5\ (K_Q/TYS)^2$	.951	.671	.675	.635		.733	.743		.742	.688	.619	.678	.635	.555	.310	
Valid K_{Ic} ?*	NO	NO	NO	NO		NO	NO		NO	NO	NO	NO	NO	NO	NO	

Material: A357-T6
Environment: Lab air
Specimen configuration: D6-4671-613

Load rate: 10000 LB/MIN
Compiled from report T6-6356
*per ASTM E399

☆U.S.Government Printing Office: 1980 — 657-084/751